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CANADIAN ELECTRONICS ENGINEERING

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May 1958
A Maclean-Hunter publication
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Casting lossy microwave parts in resin aids designer ... 16

Transistor servo amplifiers for high temperatures 21

New tools and techniques improve drafting production .. 24

Electronic equipment supervises London bus movements 28

Nultrax systems control machine tools 30

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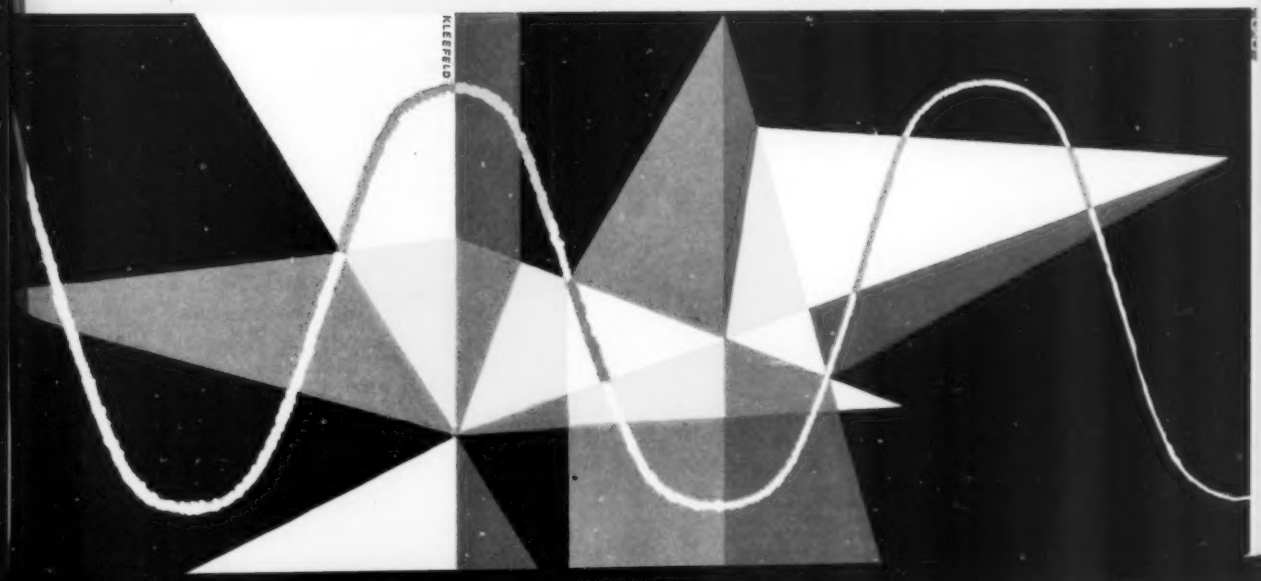

Have Trunks, Will Travel

It was a cold day in the Alps. But Hannibal, the great general on his way to conquer Rome, was very, very hot under the collar of his Punic tunic.

"How did you camel herders ever get those elephants stuck up there?" he bellowed, hanging precariously onto a ledge he shared with a mountain goat.

"I guess you could blame it on faulty radar," one of the men said. "The elephants lost their way."

"Well, I'll just have to leave you there!" Hannibal roared. "I have a date in Rome. Serves you right for forgetting that radar just can't work in the Alps without Bomac tubes!" (The general must have been talking about Bomac's peak performance. But his watch was fast — by about 2165 years.)*

So Hannibal went down in history — but his radar stayed up in the Alps. As the History Book writes:

"In search of sundry Roman scalps,
Mighty Hannibal crossed the Alps.
But he lost his radar on the way —
The Alps crossed Hannibal, you might say."

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May 1958

volume two, number 5

CANADIAN ELECTRONICS ENGINEERING

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***our cover design** — *Lossy microwave elements come in many interesting shapes. Cover artist Kleefeld tossed a few in front of a sine wave*

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a big step toward automation of wiring harnesses

Crimped pins and sockets snap-locked in plug or receptacle. Individual circuit removal or gang disconnect.

Hyfen ends the need for time consuming solder operations — and the high rejection rate inherent with solder. Pins and sockets are speedily crimped on wire ends by automatic installation tooling — or where more convenient, by bench or hand tools. Dies control and provide a uniform depth of indent which can be inspected by depth micrometer assuring absolute unvarying reliability. Crimping may be done before or after harness is in place.

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contributors and special articles in this issue:

Hobbies frequently contribute directly, in skill and information, to the work that a man does in his profession. Such is the case of **R. R. Guenett** (Nultrax systems control machine tools). At home he makes wrought iron furniture and does metal working.

At the office, Guenett is supervisor of industrial electronic control sales for Canadian Westinghouse Co., Electronics Div. A graduate of engineering from McGill in 1951, he spent a year as sales engineer for Westinghouse at their Montreal office. He then became welding engineer at Lincoln Electric Co. of Canada Ltd. In 1956 he rejoined Westinghouse in special market development of electronic controls related to the field of automation.

Guenett

Hobbies have also played an important part in the life of **J. R. Simpson** (New tools and techniques improve drafting production). They include both manual and electronic reproduction of music; this has involved several years of piano study and vast quantities of time (and money) in design and construction of audio equipment.

After five years as an electronics instructor in the RCAF, J. R. Simpson spent a year in radar field installation with Canadian General Electric. He has been with Electronic Associates Ltd. over four years and is now general supervisor of their Technical Publications Div. He is a member of IRE and has been elected chairman of the Toronto chapter of the Society of Technical Writers and Editors.

Simpson

Two engineers from Western Canada, now working for the National Research Council, prepared the story "Casting lossy microwave parts in resin aids design work." **A. Staniforth** hails from Aldersyde, Alta. He received the BASc degree from the University of British Columbia in 1938. The following year he joined the CBC as transmitter supervisor in Vancouver. He left there in 1942 to join the Radio and Electrical Engineering Div. of NRC.

Co-author **K. Steele** was born in Regina and graduated from the University of Manitoba, Electrical Engineering, in 1953. Since that time he has been with the R & EE Div. of NRC. Both authors have membership in IRE.

The second article in this issue also was prepared by two authors — this time from Defence Research Board. **P. M. Thompson** (Designing transistor servo amplifiers for high ambient temperatures) was born and educated in England. He completed a science Tripos at Cambridge University in 1946.

Thompson

After a short period at Automatic Telephone and Electric in Liverpool, he returned to Cambridge to join the Radio Physics Section of the Cavendish Laboratory. He spent two years with Salford Electrical Instruments before he sailed for Canada in 1950 to join the Radio Physics Laboratory of the Defence Research Board in Ottawa. In 1953 he was transferred to the DRB Electronics Laboratory, Transistor Section.

Since then he has remained with transistors, presenting his first important paper on the subject at the joint IRE-AIEE Philadelphia transistor conference in 1956.

At the time the design work was being done on the transistor servo amplifiers, co-author **J. Mitchell** was a member of the Electronics Laboratory, DRB. Last year, however, he moved to the United States where he is employed by Link Aviation, Inc., Binghampton, N.Y.

a Maclean-Hunter publication

Authorized as second class mail, Post Office Department, Ottawa.

Printed and published by Maclean-Hunter Publishing Company Limited. Editorial and Advertising Offices: 212 King Street West, Toronto 2, Canada. Address all correspondence: P.O. Box 100, Toronto, Canada.

Horace T. Hunter, Chairman of the Board; Floyd S. Chalmers, President; Donald F. Hunter, Vice-President and Managing Director.

Publishers of National Magazines in Canada: Maclean's, Chatelaine, Canadian Homes and Gardens. Business newspapers: Building Supply Dealer, Bus and Truck Transport, Canadian Advertising, Canadian Automotive Trade, Canadian Aviation, Canadian Electronics Engineering, Canadian Grocer, Canadian Hotel Review, Canadian Industrial Photography, Canadian Machinery, Canadian Missiles and Rockets, Canadian Packaging, Canadian Paint and Varnish, Canadian Printer and Publisher, Canadian Shipping, Canadian Stationer, Civic Administration, Design Engineering, Drug Merchandising, Electrical Contractor, L'Epicier, The Financial Post, Fountains in Canada, Hardware and Metal, Heating and Plumbing Engineer, Home Goods Retailing, Marketing, Men's Wear, Modern Power, Office Equipment and Methods, Painting and Decorating, Le Pharmacien, Photo Trade, Plant Administration, Le Quincaillier, Style. Business newspapers in U. S. and U.K.: Inland Printer, Rock Products, Concrete Products, British Printer.

Other services: The Financial Post Corporation Service; Canadian Press Clipping Service; Commercial Printing Division.

Offices at 1242 Peel Street, Montreal; Room 1004, The Burrard Bldg., 1030 West Georgia Street, Vancouver 5, B.C.; Maclean-Hunter Limited, 125 Strand, London, England.

Subscription rates: Canada $5.00 per year, two years $9.00, three years $12.00. Single copy price $1.00. U. S. A., United Kingdom, $10.00 per year; all other countries, $20.00 per year.

Indexed in Engineering Index.

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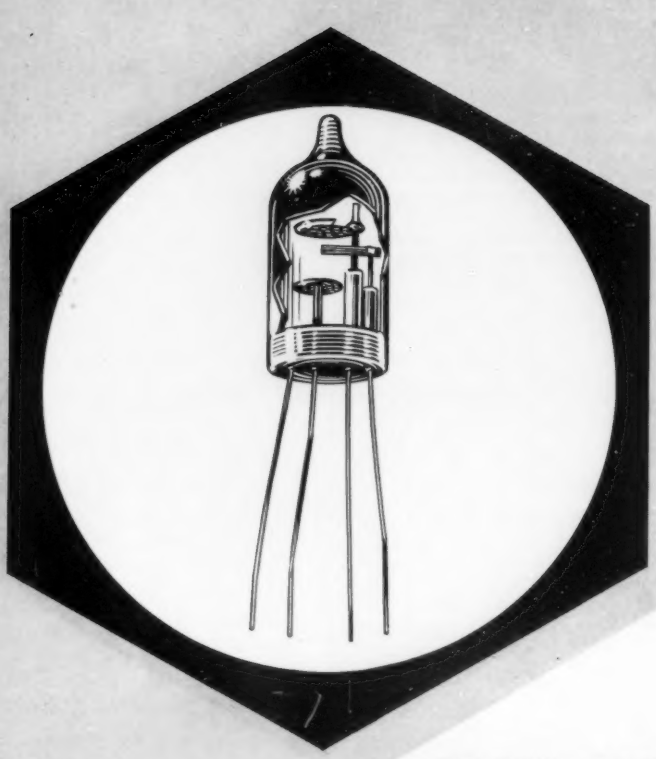

The Philips Z 70 U is a cold cathode trigger tube of sub-miniature construction. It has a special primer electrode which operates in complete darkness without ignition delay. Its small size (1″ x 0.4″), long life and narrow tolerances makes this Special Quality* tube particularly suitable for counting, switching, relay and "on—off" applications up to 5,000 operations per second. During the entire life of the tube the anode to cathode burning voltage remains between the limits of 113 to 121 volts. The Z 70 U has a continuous cathode current rating of 3 mA and a peak cathode current rating of 12 mA. The tube has flying lead connections making it suitable for printed wiring applications.

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★ Rogers Electronic Tubes are sold through Canada's Independent Electronic Parts Distributors

News highlights . . .

More orders for transmitter firms . . .?

DOT has lifted power ceilings on many Canadian radio broadcasting stations. Reason: rapid growth of metropolitan areas has made existing power limits (regional stations—5,000 watts; local stations—250 watts) inadequate for proper service in many areas.

Computer users swap programs . . .

Utilities, electric equipment and computer manufacturers are now exchanging complete problem programs as well as mathematical subroutines. Working through committees of the AIEE, the co-operating groups have already made available programs for 92 utility engineering and other problems.

More technicians to be trained . . .

Over 70 students are taking the electrical and electronic courses introduced last fall at the Hamilton Institute of Technology. Principal D. H. Craighead predicts the enrolment will double next September. Also, night classes have started at the new AMJ Electronics College in Ottawa.

High school students, too . . .

An experimental course in electronics will be open to a small number of grade 10 students when Burnaby's new Central High School opens this fall. First of its kind in B. C., the course has been approved by the department of education.

Controlled rectifier as regulator . . .

New semiconductor devices and applications seem to crop up daily. Latest is the use of General Electric's recently developed "controlled rectifier" for precise regulation of dc power supplies. They claim faster response and higher performance than with magnetic amplifiers or power tubes, along with greatly reduced size and weight as the device's advantages in this application.

Marconi president looks at 1958 . . .

"There is reason to expect that your company will begin to benefit from the forward engineering and planning in which so considerable an investment has been made in recent years." This forecast, which it is hoped can be applied to many other firms in this industry, was made by S. M. Finlayson of Canadian Marconi in his annual report for 1957.

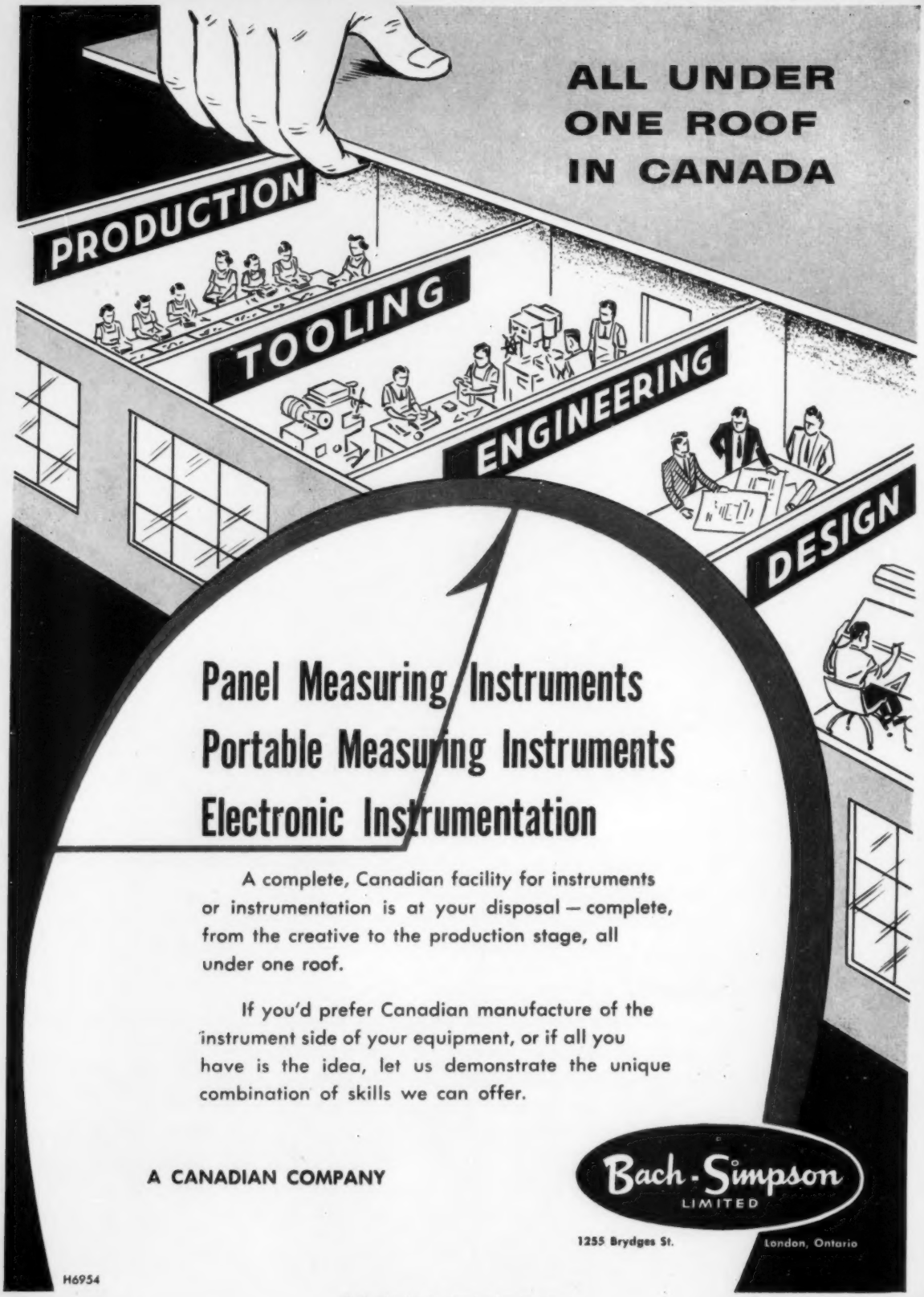
RETMA: New standards activity . . .

The Engineering Committees of both the Components and Receiver Divisions met during April and adopted new standards for use in Canada.

A new RETMA internal standard proposal for Audio Output Transformers for Radio and Television Receivers will soon be finalized. This will complete about two years' work by the Transformer Engineering Subcommittee.

A limited number of copies of an important paper by C. M. Brant of DOT: "A Canadian point of view on radio frequency spectrum management" are available free of charge from the Canadian Radio Technical Planning Board at 200 St. Clair Avenue West, Toronto 7, Ont.

The executive committee of the CRTPB recently discussed the Board's participation in the forthcoming meetings of CCIR and ITU. The Board will provide valuable assistance to DOT, who will represent Canada at these important conferences, to be held in San Francisco in 1959 and in Geneva in 1960.



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Authority on radiotelephones heads B.C. Telephone Co.

Cyrus H. McLean, the man who pioneered commercial radio telephone service on the British Columbia coast, has been elected president of the British Columbia Telephone Co. He replaces **Gordon Farrall,** who held the post for 30 years and who has now been named chairman of the board.

Mr. McLean who was born in Prince Edward Island and came to Vancouver at an early age, joined the B. C. Telephone Co. in 1916. When the North-West Telephone Co. was created to establish a radio-telephone system on the coast, Mr. McLean was named radio engineer. Subsequently he directed similar work in South America, the West Indies and the Philippines. Latterly he has been stationed in New York as director of foreign operations for the General Telephone Corp., top company of the General Telephone System, which operates the largest group of non-Bell telephone companies in the world.

Engineering Institute of Canada elects new president

K. F. Tupper has been elected president of the Engineering Institute of Canada and will be installed in office at the annual convention May 21-23 at Quebec City. Mr. Tupper is president of Ewbank and Partners (Canada) Ltd., Toronto, thermal and electrical engineering consultants. He has had experience in nuclear science, being one of the original engineers to work at Chalk River. Prior to joining Ewbank and Partners, Mr. Tupper was dean of the Faculty of Applied Science and Engineering at the University of Toronto.

General secretary for Canadian Council of Professional Engineers

Leopold Maurice Nadeau, P. Eng., of Montreal, has been appointed general secretary of the 32,000-member Canadian Council of Professional Engineers. He will co-ordinate the activities of the engineering licensing bodies of which there are 11 — one in each province and one in the Yukon. His headquarters will be in Ottawa.

Mr. Nadeau is a graduate in Applied Science and Civil Engineering, L'Ecole Polytechnique, Montreal.

National Research Council honors and appointments

Dr. E. W. R. Steacie, president, National Research Council of Canada, has been elected an Honorary Fellow of the Chemical Society of London, this is in recognition for his work in the field of gas reactions and photo chemistry.

Dr. Steacie was born in 1900 in Westmount, Que. and graduated from McGill University in 1926 with the degree of Ph.D. in physical chemistry. He joined NRC in 1939.

Dr. J. W. T. Spinks and **Dr. J. T. Wilson,** have been appointed by the Governor General in Council as new members of the National Research Council. Dr. Spinks is head of the Department of Chemistry, University of Saskatchewan and Dr. Wilson is Professor of Geophysics, University of Toronto.

Aerovox sales representative for Quebec and Maritimes

W. J. McIntyre has been appointed sales representative for Aerovox Canada Ltd. in Quebec and the Maritimes. He will operate from his offices at McIntyre Agencies, 7365 Mountain Sights, Montreal, Que.

Canadian National Telegraphs start communications research

Special research projects into various phases of communication engineering will be undertaken by **S. W. Walker.** He was recently appointed to the newly-created post of special assignments engineer. He is a graduate from the University of Toronto, Electrical Engineering 1923, and first joined C.N. in 1925.

R. C. Griffin, a graduate from Nottingham University, England, succeeds Mr. Walker as general equipment engineer of C.N. Telegraphs.

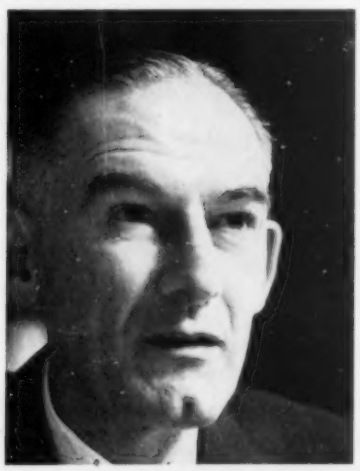
Daystrom adds to sales staff

D. Beattie, P. Eng., has been appointed Ontario sales manager of Daystrom Ltd. He has been with the company since its formation last year. Sales representative for the Eastern Ontario and Scarborough districts is **R. F. Ryan.** Sales representative for Hamilton, Niagara Falls and Western Ontario districts is **G. Rosamond.**

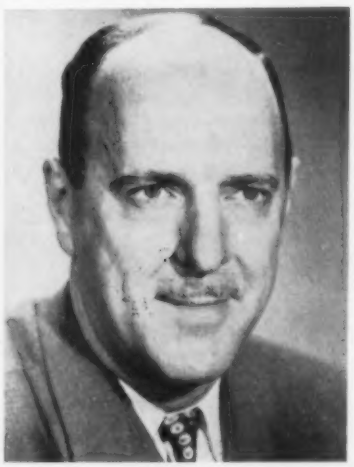
Westinghouse appoints K. F. Adams

Rear Admiral Kenneth F. Adams has been appointed manager, Commercial Development at Canadian Westinghouse Co. Ltd. He recently retired from the Royal Canadian Navy following 33 years' service. With the formation in 1953 of a new establishment at Hamilton to administer Canada's 22 naval reserve divisions, he became Commanding Officer Naval Divvisions. He was promoted to Rear Admiral in 1955.

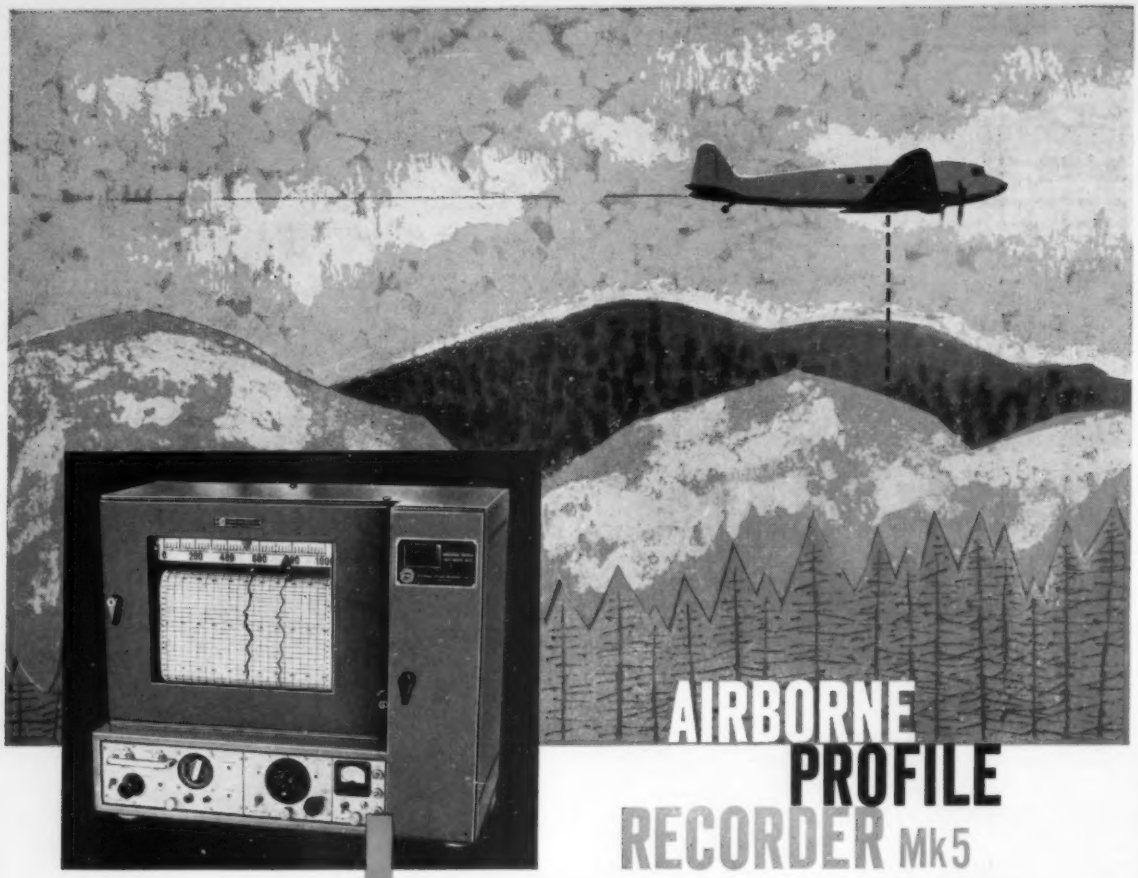
McLean



Tupper



Nadeau



AIRBORNE PROFILE RECORDER Mk5

Capable of measuring terrain clearance from 1,000 to 35,000 feet, this instrument is designed for air survey work to determine the relative heights of points on the ground along the flight path of an aircraft. Two simultaneous continuous records are provided on a paper chart—the corrected terrain profile and the terrain clearance.

An exceptionally accurate height deviation indicator, operating on a hyposmetric principle, detects and automatically compensates for variations from the chosen barometric flying height, thus producing an exceptionally accurate terrain profile record.

SPECIFICATIONS

Total Weight: 176 lbs. (made up of six units).

Power: Constant demand 26-28v dc, 23-25 amp.

Operating Height: 35,000-ft. max.; 1,000-ft. min.

Antenna System: Double dipole in 44-in. diam. reflector.

Frequency: X band (3.2 centimetres).

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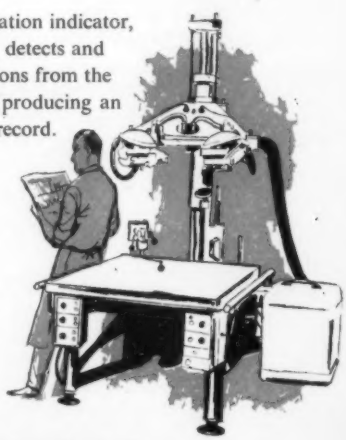

The recordings, when used as a reference in conjunction with the Gamble stereo plotter, illustrate constantly new development being brought into field application by C.A.R.L.

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Sparrow II missile to be produced in Canada for RCAF

Canadair Limited of Montreal has been commissioned by the Department of Defence Production and the Royal Canadian Air Force to go into immediate production on one of the world's most modern, high-performance, air-to-air guided missiles.

Named the Sparrow II, it will be the first Canadian-built operational missile, and will be supplied to Air Defence Command of the RCAF. The number of units was not revealed.

Under the terms of the contract, Canadair is appointed co-ordinating contractor, and as such has the overall responsibility for the manufacture, assembly and flight testing of the missile. For the past seven years, Canadair and other companies have been engaged in programs in Canada for the development of guided missiles.

Although details of the missile are still on the secret list, it is known to be rocket-powered and able to fly several times the speed of sound. With its small but very powerful rocket motor, and its built-in radar-seeking system which guides the missile to its target, the Sparrow is a match for any present manned operational airplane.

Canadian Westinghouse Company Ltd. of Hamilton, has been appointed an associate contractor to produce the radar-seeking system. Firms who will do subcontract work for Canadair on the program are Aviation Electric Ltd., The de Havilland Aircraft of Canada Ltd., and Sperry Gyroscope Company of Canada Ltd.

The missile is to be produced under a license agreement negotiated between the Canadian Government and the Douglas Aircraft Company, Inc. in California, and with the concurrence of the United States Navy.

Companies expand facilities

Tele-Radio Systems Ltd. has been incorporated and has moved to new offices at 3534 Dundas St. W., Toronto 9. The company has also been appointed exclusive representatives for Canada by Budelman Radio Corp. of Stamford, Conn., manufacturers of telephone line carrier and point-to-point 450 and 960 mc radio links.

To gain a more distinctive name, Electronic Enterprises Reg'd. is now called Conway Electronic Enterprises Reg'd. Offices have been moved to 1514 Eglinton Ave. W., Toronto 10, to allow for company expansion. The company has also been appointed exclusive Ontario distributors for the Advance Company of England (af, rf, vhf and uhf generators, crystal calibrators, magnetizers, etc.).

Computing Devices of Canada Ltd., Ottawa, recently opened a branch sales office at 164 Eglinton Ave. East in Toronto, managed by R. G. Powers. A Bendix G-15D digital computer has been installed, primarily for sales demonstration purposes, and is being used in a series of courses on programming for engineers, presented by CDC staff members.

R. H. Nichols Ltd. moved in mid-April to their new offices and factory at 4544 Dufferin St., Downsview, Ont. The new building provides about 50% more space.

Cossor (Canada) Ltd. of Halifax, N.S. will be moving into a new $400,000 plant near their present facilities. The factory will be built and leased to Cossor as the first big project of Industrial Estates Ltd., Nova Scotia's crown company set up to develop industry in the province.

Canadair Limited technicians check control surfaces of Sparrow II missile

Big month ahead for CEWA members

May will be a busy month for members of the Canadian Electronic Wholesalers' Association. Annual meetings of the Western division will be held at Winnipeg on the 12th and of the Eastern division at Niagara Falls on the 14th.

These will be followed immediately by the CEWA annual meeting and convention in the Sheraton-Brock Hotel at Niagara Falls, May 14-16. Keynote speaker at the convention dinner May 15 will be **Joseph R. DeMambro** of Boston, Mass., president of the National Electronic Distributors Association (NEDA) in the United States.

Most of the delegates are expected to proceed to the 1958 Electronic Parts Distributors Show, to be held May 19-21 in Chicago. Canadian HQ at the Show will be run by C. G. (Jerry) Pointon and John T. Rochford and the fifteenth annual Canadian Luncheon will be held May 20.

DeMambro

Lowles

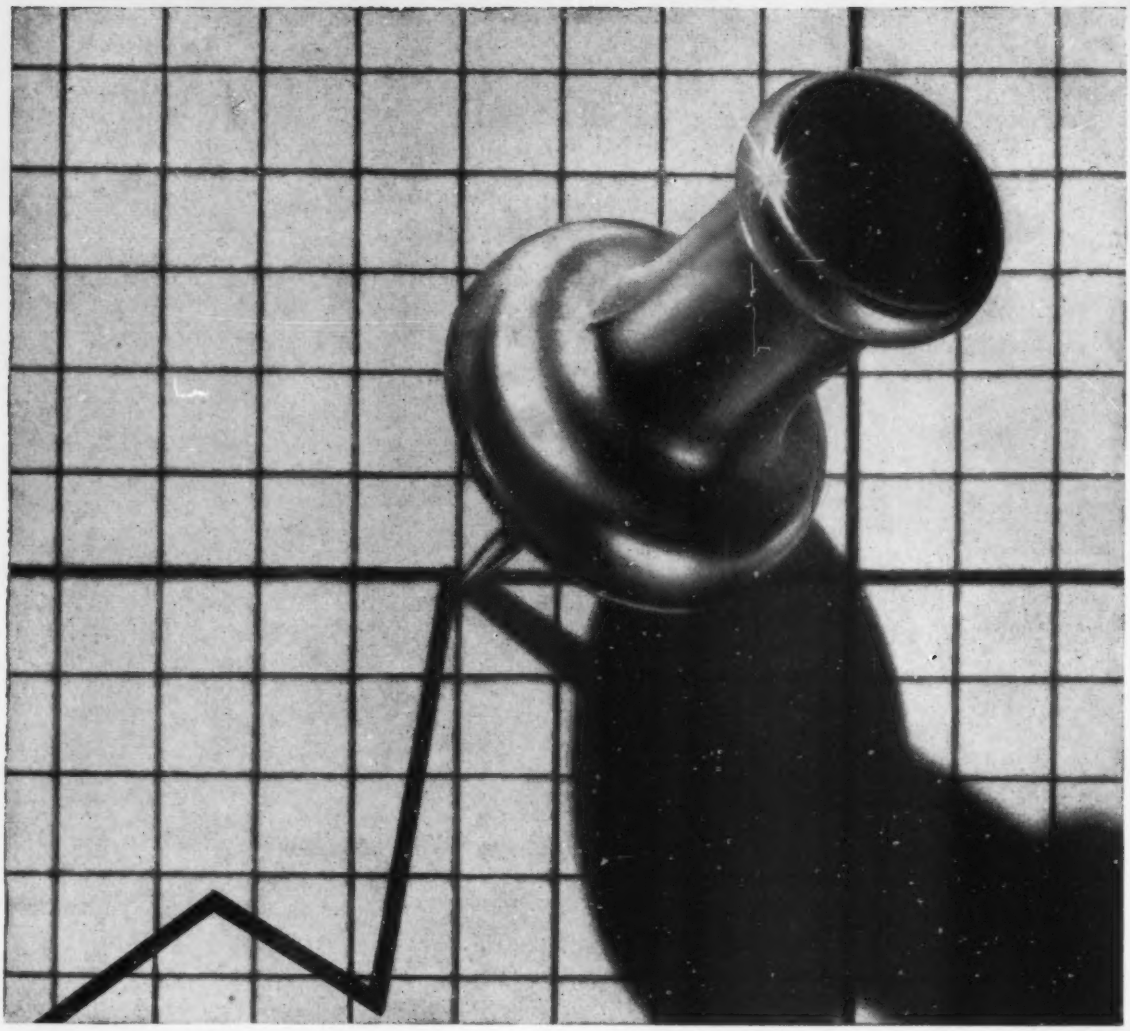
International Nickel opens Montreal office

International Nickel Research & Technical Services Ltd. has opened a Montreal office in Room 808-9, Dominion Square Building. **G. A. Lowles** is in charge of the new office, which will provide technical information and fabrication advice to users of nickel and nickel alloys in Quebec, minion Square Building. **G. A. Lowles** is in charge of the new office, graduate of McGill, has been with International Nickel since 1948.

More electronics firms get DDP contracts

Recently awarded unclassified contracts for $10,000 or more include: Cossor (Canada) Ltd., Halifax, electronic components, $15,290; Electronic Materiels International Ltd., Ottawa, modification of airborne communications equipment, $201,714, also installation and testing of radio equipment, $10,099; Ampex American Corp., Toronto, electronic equipment, $13,164; Canadian Aviation Electronics Ltd., Montreal, technical services, $11,391, also airborne transmitter-receivers, $46,892; Canadian Line Materials Ltd., Ottawa, electronic

(Continued on page 45)



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Once every year, the auditor from Canadian Circulations Audit Board Inc. checks our address records. If he checks your name, he will want proof of the business you are in, and that your address is correct. The proof may be a letter from you, or it may be a listing of your name in a directory, or it may be a salesman's report after calling upon you.

The auditor's most recent check of our circulation, summarized your name and others on our lists in this manner:

Classifications	Canada	Foreign	Total
Manufacturers of Electronic Equipment and Components, Radio, Television and Communications Equipment	2,159	11	2,170
Telephone and Telegraph Companies	1,196	1	1,197
Public and Privately owned Utilities	908	—	908
Radio and Television Stations, Recording Studios	510	—	510
Government (N.R.C., D.R.B., A.E. of C., D. of T., Armed Services)	585	3	588
Airline, R.R., Communications, Police, Fire, etc.	207	—	207
Universities and Private Research Laboratories	220	—	220
Industries using Electronic Equipment in Manufacturing and Processing	750	—	750
Hospitals	370	—	370
Distributors of Electronic Equipment	188	—	188
Engineering Firms and Individual Engineers	518	1	519
Manufacturers Incorporating Electronic Equipment in their Finished Product—Aircraft etc.	499	—	499
Miscellaneous and awaiting classification	30	3	33
TOTAL	8,140	19	8,159
Average for the Period			8,402

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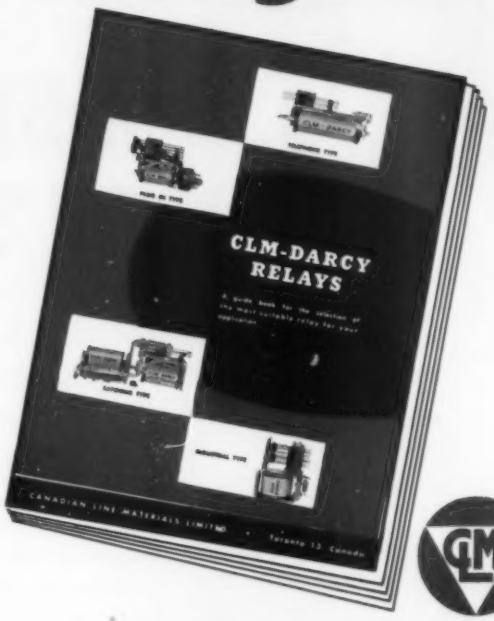

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Is this the breakthrough?

Canada's aircraft and electronic industries have been charged with the responsibility of producing the Sparrow II air-to-air guided missile for the RCAF. Reported more fully on page 9, this announcement will have been greeted with enthusiasm, we are sure, not only by the companies who will contribute to the program, but also by the Canadian electronics industry as a whole.

While international conditions remain as they are, Canada, along with the other Western democracies, must keep its defenses strong. The members of the Gordon Royal Commission concluded that the country's defense burden, now about $1.7 billion a year, would likely continue to be heavy for the next two or three decades. They also suggested, naturally, that the electronics industry would be one of the biggest suppliers of defense needs.

Until this latest news broke, there was not much evidence of a start to this predicted upswing in defense electronics procurement. In fact, the figures published in our February issue indicated the opposite. It was natural that pessimism prevailed in some quarters, aggravated to some extent by events such as the awarding of the development contract for the CF-105 integrated radar and fire control system to a non-Canadian company.

It is inevitable, therefore, that the confidence expressed in the capabilities of Canadian industry by the announcement of the Sparrow II production contract will act as a shot-in-the-arm. We, in turn, are confident that Canadian electronics manufacturers can meet the challenge. Not only of the present task, but also of the many more complex problems that lie in the era, just ahead, when missile-armed manned aircraft are made obsolete by the missiles themselves.

IRE Canadian Convention

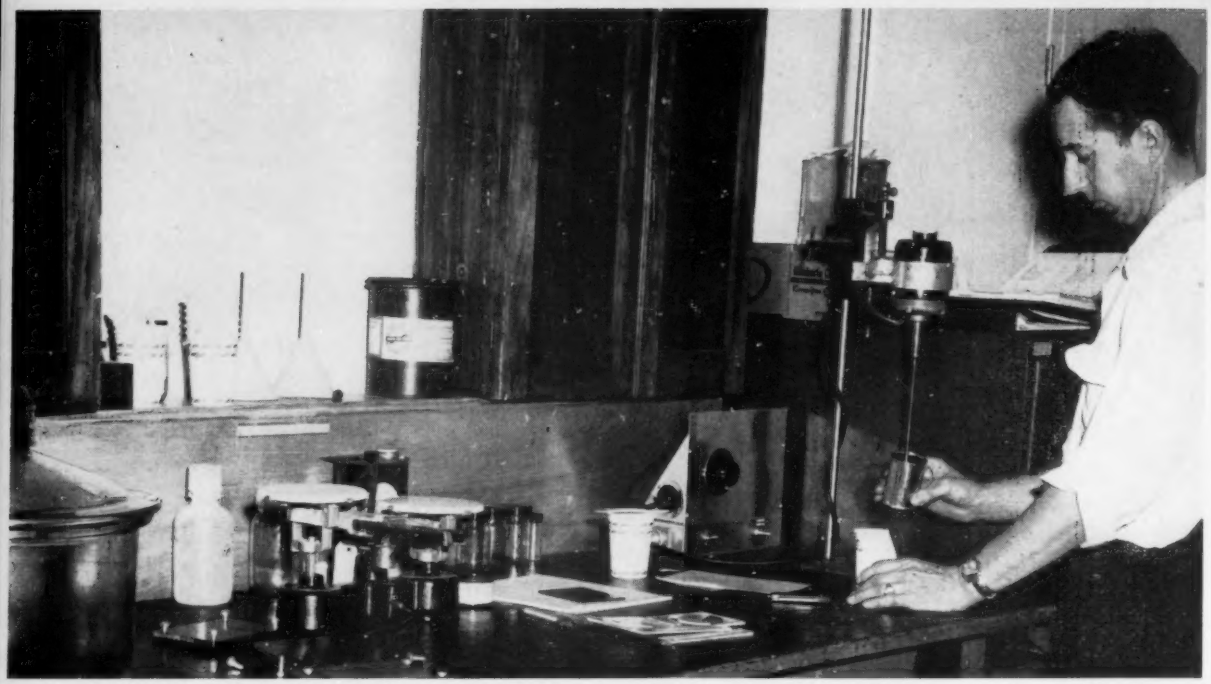
Also reported in this issue is the IRE National Convention and Radio Engineering Show. This prompts us to remind all our readers that it is not too early to plan attending the 1958 IRE Canadian Convention, to be held in Toronto at Exhibition Park, October 8, 9 and 10.

More urgent is the need for prospective authors of papers to submit their summaries (500 words) and abstracts (100 words) to the Technical Program Committee before the May 31 deadline. Send them to Mr. A. P. H. Barclay, IRE Canadian Convention, 1819 Yonge Street, Toronto 7, Ontario.

CEE lights first candle

Although this issue is labelled "volume two, number five" it is actually our thirteenth. Despite the usually unlucky connotations of this number, we feel proud to have completed our first year of service to the Canadian electronics industry. Humble, too, in that we trust our many friends will continue to help us grow and improve our service.

THE EDITOR



Technician at National Research Council Lab. mixes ingredients in disposable can before casting lossy microwave part

Casting lossy microwave parts in resin aids design work

A. STANIFORTH AND K. A. STEELE*

This article describes a relatively simple and inexpensive method of producing lossy materials for use in experimental microwave work. Tests using iron powder filler in some of the casting resins have been carried out at the National Research Council Laboratories. The results of these tests are discussed, along with information on the properties of the materials used. Applications of the lossy microwave components in various types of transmission line are then considered

In experimental microwave circuitry the first design of an attenuator or termination is rarely the ideal one. So it is usually desirable to be able to change either the shape or loss factor of the lossy material fairly easily. Commercially available materials are not always suitable for experimental applications. Materials such as polyiron can be machined only by grinding. Resistance card material can be cut to shape but does not always have the required impedance or attenuation. A material having suitable characteristics for many applications can be made by mixing a filler or iron powder in one of the casting resins.

The ideal properties of a resin and metal powder mixture when used as a microwave absorbing material in a transmission line are:

a) The material should have a high loss factor

b) The wave impedance, which is proportional to

$$\sqrt{\frac{\text{the complex permeability}}{\text{the complex dielectric constant}}} = \sqrt{\frac{\mu}{k}};$$

should be close to that of the dielectric in the remainder of the line.

The properties of dispersions of small conducting particles in a dielectric at microwave frequencies have been dealt with fairly extensively in the literature noted under "References." The main considerations are indicated briefly in the following four points.

1. Conducting particles in a medium will increase the dielectric constant, as the concentration is increased, whether or not the particles are magnetic. The more iron powder that is added to the resin, the higher the dielectric constant will be.

*National Research Council, Ottawa.

2. If the particles are non-magnetic or weakly magnetic, the permeability of the mixture will be less than one and will approach zero as the concentration of the particles is increased. Thus, in a transmission line, the impedance, which is proportional to $(\mu/\kappa)^{\frac{1}{2}}$, will decrease rapidly because κ is increasing and μ is decreasing.

3. If the particles have a medium to high permeability, the effective permeability of the mixture will be greater than one and increase with concentration. With available materials κ is always greater than μ. Thus, in a transmission line, the impedance will not decrease as rapidly as in the previous case, as both κ and μ are increasing with concentration. In practice, some form of impedance transformation such as tapering, is required to obtain a low vswr.

4. The loss factor of the material is generally due mainly to an increase in the magnetic loss tangent whether or not the conducting particles are magnetic.

Particle size affects the attenuation

Figures 1, 2, and 3 indicate the relative loss of several materials at X-band. The relative attenuation of several metal powders is shown in Figure 1. Particle size, resistivity and permeability affect the attenuation of the material and determine the frequency at which the loss becomes large. Since samples of metal powders generally contain a wide range of sizes and shapes, and little is known about their permeability, prediction of properties is very difficult. Tin has a resistivity about that of iron, but since it is non-magnetic, the loss is much lower. Stainless steel 316 is non-magnetic and it is probably because of this that it is less lossy than the 410 stainless steel. The difference between the stainless steel powders and the IRN-31 powder is likely due to the difference in their resistivities. Stainless steel has a resistivity four to eight times that of iron.

Figure 2 compares the attenuation of iron powder base materials with graphite base materials. The graphite and powdered irons are mixed in epoxy resin. The synthane is a 300 ohm per square material, 1/16-inch thick.

The three carbonyl iron powder mixtures of Fig. 3 were made to a common viscosity, which determined the upper limit of iron concentration in each case. When compared on this basis, the difference in the particles sizes does not make a great deal of difference to the attenuation of the material.

A list of manufacturers of resins and iron powder that have been used at the National Research Council is shown in Fig. 4. Probably there are resins from other sources that would be equally satisfactory.

Choice of resin is important

The liquid epoxy resins and polyester resins are very well suited for experimental work, as they can be prepared and cured at room temperature or a low oven temperature of about 200 F. In addition, they are hard, thermosetting compounds with very little shrinkage on curing—even less shrinkage with the metal powder filler. (Araldite 6010 resin, unfilled, has a shrinkage of .004 inches per inch.) Also their adhesion to metals and ceramics is very good. Most of the epoxy resins are useful up to about 200 F when post-cured for 2 or 3 hours. The Epon 828 resin retains good mechanical and electrical properties up to 300 F when post-cured at 250 F for 4 hours.

The unmixed materials may be stored for at least one year without serious deterioration when kept in a cool place—preferably a refrigerator.

One disadvantage of this material is the low heat conductivity which limits the amount of power that can be dissipated. As an example, an ordinary flap type of termination in X-band guide will be damaged by 7 watts average power of a pulsed magnetron of 7 kw peak output. The

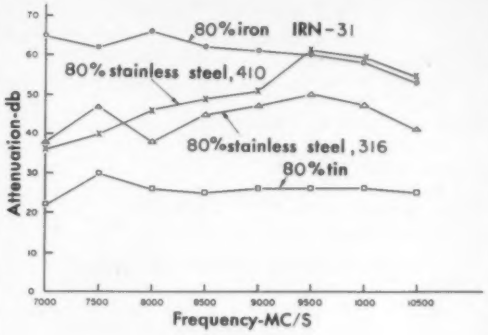


Figure 1

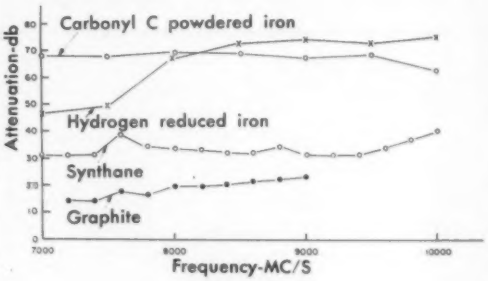


Figure 2

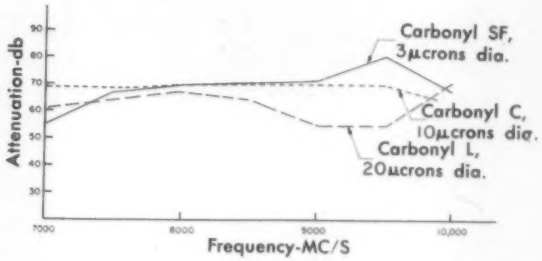


Figure 3

Fig. 4. CASTING RESINS & IRON POWDERS USED AT NRC LABORATORIES

EPOXY RESINS			
	Araldite 502		Ciba Co. Ltd.
	Araldite 6010		
	Epon 828		Shell Chemical Co.
	Hysol 6020		Hysol (Canada) Ltd.
POLYESTER RESIN			
	GE 403		General Electric Co.
IRON POWDERS			
	Carbonyl Type L	20 Microns Dia.	Antara Chemicals
	Type C	10 Microns Dia.	
	Type SF	3 Microns Dia.	
	Hydrogen Reduced IRN 31		Williams Co.
	IRN 2		
	SPN 434		Pyron Co.

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Fig. 5 MIXTURE RATIOS

		Parts by weight
POLYESTER RESIN	GE 403	100
Styrene Monomer		11
Benzoil Peroxide		1.7
ARALDITE EPOXY RESIN	6010	100
Hardener	HN 951	12
HYSOL EPOXY RESIN	6020	100
Hardener	A	11
EPON RESIN	828	100
Curing Agent	CL	15

IRON POWDER CONCENTRATIONS

Maximum Amounts

IRN 31 IRN 2	80% Iron by weight
PYRON 434	75% Iron by weight
CARBONYL TYPES	81-89% Iron by weight

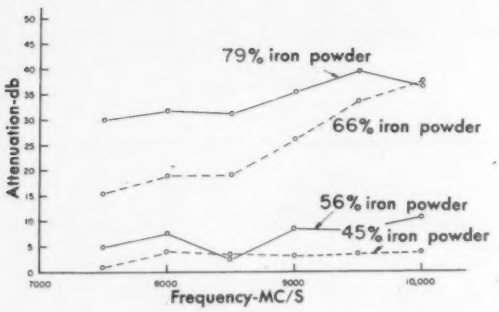

Figure 6

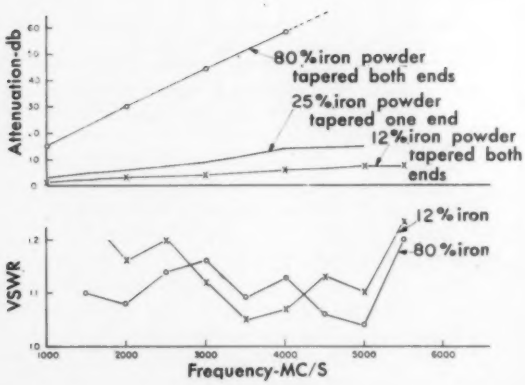

Figure 7

power that can be dissipated without damage depends upon the shape and the concentration of iron powder in the component.

Iron powders give best performance

The iron powders used represent a variety of particle sizes and shapes. The carbonyl irons are spherical in shape, and may be purchased in a range of diameters from 20 microns to 3 microns. The hydrogen-reduced iron powders are irregular in shape, and are slightly magnetized so that they tend to cling together in groups. A sample may contain a large range of sizes from 3 microns to 50 microns.

Other powdered metals tested include brass, aluminum, tin and stainless steel. These were found to be less satisfactory, because of lower loss than the irons (see Fig. 1).

Figure 5 shows the mixing ratios of several of the resins and their hardening agents. The maximum percentage of iron that may be added is determined by the viscosity. The addition of the powdered metal increases the viscosity of the mixture. As the proportion is increased above a critical value, the material becomes so stiff that air bubbles are trapped during the mixing. Also when the mixture is placed in the mold it is very difficult to force it into thin sections and into corners without leaving cavities.

The maximum percentage of iron that can be added varies somewhat with the type. About 80% by weight of IRN-31 is maximum, whereas Pyron-434, having a lower density, can be mixed only up to 75%. The same viscosity is reached with 81% to 89% of carbonyl iron, the finer particles allowing higher proportions of iron. This higher attainable concentration is probably the result of the spherical particles in the carbonyls flowing over one another more easily than the irregular particles of the hydrogen-reduced iron. The theoretical maximum amount of spherical iron particles in resin is about 90% by weight, without using pressure.

Varying the iron powder concentration affects the attenuation as shown in Figures 6 and 7. When iron powder concentrations of less than about 65% by weight are used, the viscosity is low enough for the iron to settle out before the mixture has cured. In this case, a filler is added to increase the viscosity and prevent the settling. Ground mica, talc or phenolic micro-balloons have been used successfully. Figure 7 also illustrates the relatively rapid decrease in attenuation of the material with frequency at L-band and S-band. This occurs with all the materials which have been used.

Impedance matching of lossy components by tapering or reduction of iron powder concentration is shown in Figures 8, 9 and 10. Both tapering and reduction of concentration lower the total attenuation, but a vswr of 1.1 or less over a broad band can be obtained fairly easily. The attenuation of the stripline pad of Fig. 8 is given by the middle curve on Fig. 9. The attenuation of the 80% iron powder component of Fig. 10 was not measured as its vswr was considered to be too high to be acceptable. 50 ohm type-N connections were used on all the coaxial line and stripline components.

Resin and iron powder must be thoroughly mixed

The first step in the manufacturing procedure is to weigh out the resin and the iron powder rather carefully. Then mix them thoroughly together, preferably with a small mechanical mixer, until homogeneous. Heating the resin to about 150 F will decrease the viscosity considerably. This may be done when the maximum proportion of iron powder is to be added.

The next step is to weigh out the correct amount of hardener or curing agent, and mix it thoroughly.

As an alternative, the three ingredients—resin, hardener, and iron powder—may be mixed together from the

start. This is often an advantage, as the hardening agent lowers the viscosity considerably. For instance, Araldite 6010 resin at 73 F has a viscosity of 16,000 centipoises. When the hardener is added, the viscosity is reduced to 2,000 centipoises. Some time after mixing with the hardener, the material will begin to harden. This time is called the pot life, and will depend upon the batch size and temperature. The larger batches and higher temperatures have a shorter pot life. 100 grams of resin, about a 4-oz. jar full, has a pot life of about 30 minutes at room temperature. The reaction is exothermic, so the mixture temperature will start to rise as soon as the hardener is added, thus shortening the pot life.

Air must be vacuumed out of mix

After mixing, the compound is ready to be vacuumed by placing in a bell jar, and vacuum pumping for a few minutes. The mixture will bubble up at first, then subside as the air is driven out of it. This step is quite important, to get the maximum attenuation in a given sample.

Figure 11 indicates the effect of leaving the air bubbles in a mixture. The amount of trapped air will vary from one sample to the next, as it is dependent on the viscosity. For uniformity of results, vacuuming the resin-mix is quite important.

On page 16 is a view of the laboratory equipment at the National Research Council Laboratories. The scales used for weighing out the ingredients can be seen, and also the simple type of mechanical mixer used. As the resin is thermosetting, and few solvents will affect it, it cannot be readily cleaned out of the containers. Disposable paper cups and wooden stirring spoons are almost a necessity. When the procedure calls for heating and stirring the mixture, the paper cups are not too robust. In this case baby food tins make very useful disposable containers.

Previous to preparing the mixture, a suitable mold must be made. Almost any convenient material may be used. For small parts, teflon, polyethylene or PVC plastisol are good materials as they require no mold release compound. When metals, polystyrene or vinylite are used, they must be coated with a release agent such as Dow Corning Resin No. 7, or Dow Corning High Vacuum Grease. When a mold is made of wood or other porous material, a lining of thin plastic sheeting such as Saran, Mylar, Teflon or polythene should be used. It is preferable to make the mold in two halves for easy removal of the cast piece. If wedge-type flat loads are to be made, it is often convenient to pour the mix directly into the waveguide in which it is to be used. Metal blocks of correct shape, coated with release agent, are inserted in the guide to obtain the required taper.

Resin mix may be molded in various shapes

Flat sheets can be made with close control on the thickness by using two steel plates about ¼ inch thick, spaced with wire, the diameter of which is the required thickness of the finished product. The wire is formed to surround the sheet. The mix and wire loop are placed on one plate, the other plate is placed on top, and the assembly pressed together with C clamps or a vise.

After vacuuming, the mixture is placed in the mold, care being taken not to trap any air which will leave cavities in the finished product.

The material is next cured in the mold. The curing time depends on the temperature.

Temperature	Cure Time
70 F	24 hours
150 F	1 to 2 hrs.
212 F	30 minutes

When the cast piece is not of the required shape, it may be finished by machining. The iron-resin mixture may

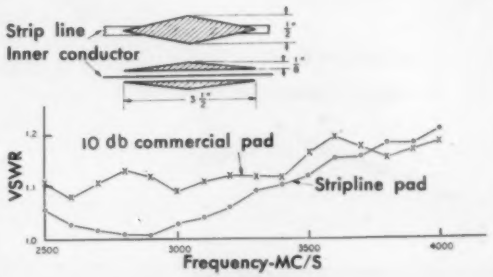

Figure 8

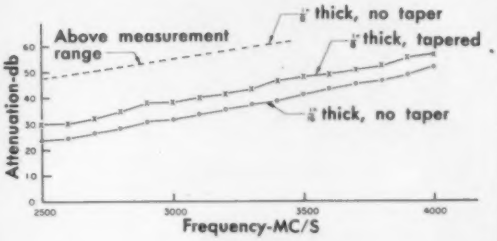

Figure 9

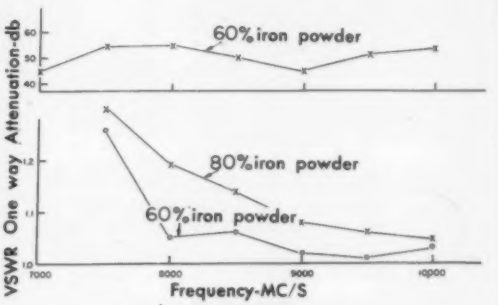

Figure 10

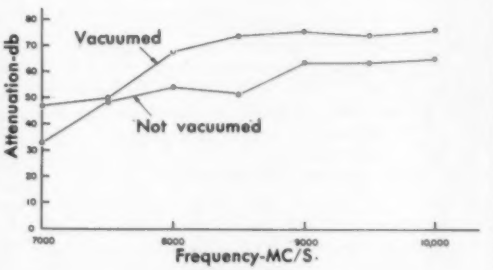

Figure 11

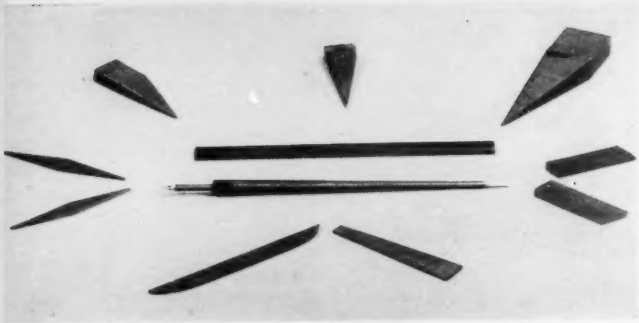

Figure 12

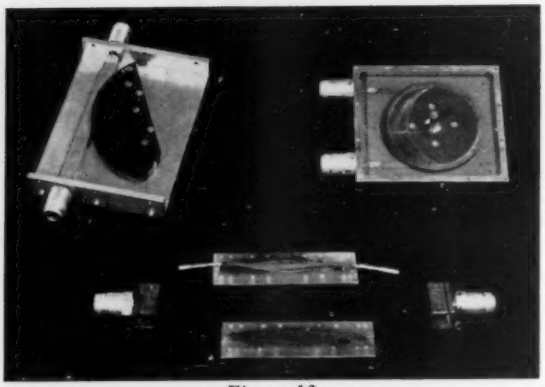

Figure 13

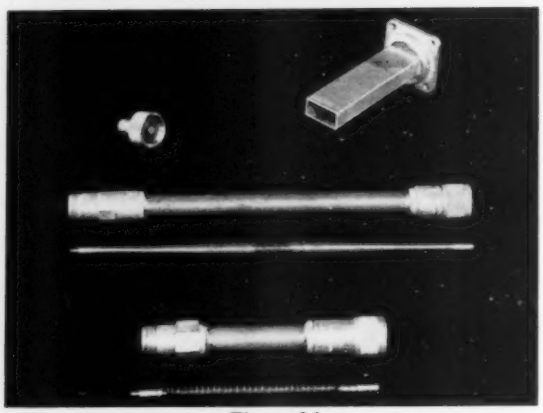

Figure 14

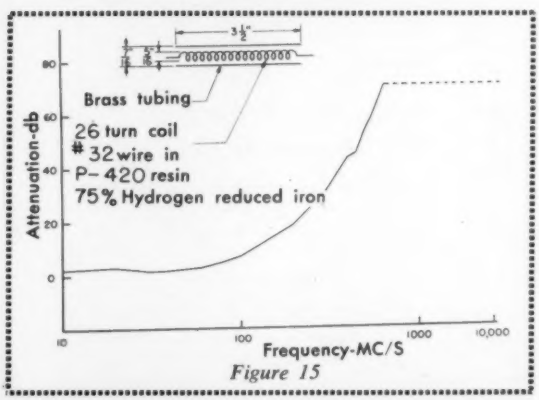

Figure 15

be readily turned or bored on a lathe, preferably with a tungsten carbide tool, as ordinary tool steel is dulled fairly quickly. A convenient method used to bring flat surfaces to the correct dimensions, is to saw the pieces roughly to shape and finish on a sander.

Figures 12 to 14 show some of the components that can be readily made by the process.

Lossy material makes good transformer core

The performance of a low-pass broad band filter is shown in Fig. 15. This is made by winding a helix on a cast rod of powdered iron-resin mixture and then casting with more lossy material in a metal tube. Type-N connectors are used. The impedance match can be improved by tapering the pitch of the helix and its diameter. The cut-off frequency can be changed by adjusting the helix length, pitch and diameter.

As the permeability of the higher concentration of iron in resin is about 8, another suggested use is as a core material for RF and pulse transformers. A 1:1 pulse transformer was successfully made at this laboratory using a cup core casting.

These are but a few of the many possible applications of this material. As it does not involve expensive equipment to fabricate and it can easily be cast and machined, the material is ideal for experimental purposes.

Acknowledgments

Mr. W. L. Haney, Head of Defence II Section, contributed many valuable suggestions. Mr. Jack Stewart made most of the components. END

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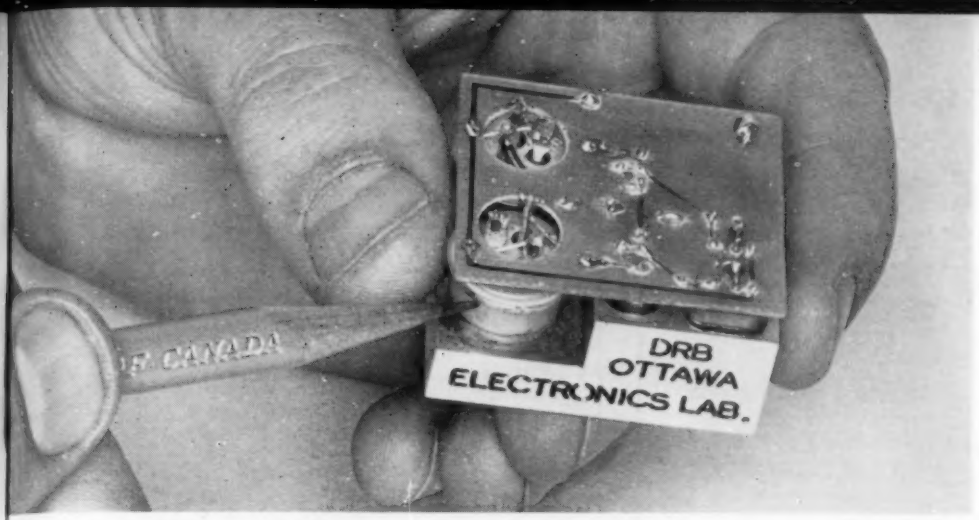
Correction

Please note the following corrections of typographical errors in the article "Fundamentals of Magnetism" which appeared in the April issue.

The values of energy product given at the bottom of page 25 and the top of page 26 as 0.525×10^6, 0.6×10^6 and 0.5×10^6 should read 5.25×10^6, 6.0×10^6 and 5.0×10^6 respectively. Also, the point (b) in fig. 3 which is referred to in the text on page 26, was omitted from the illustration. It is the point where the straight line from point (a) intersects the zero oersteds axis, at a value of 11.3 kilogauss.



Designing transistor servo amplifiers for high ambient temperatures

P. M. THOMPSON* and J. MITCHELL†

It is possible to design transistor servo amplifiers to operate at ambient temperatures close to the maximum storage temperature of their transistors if both the mean and peak power dissipated at the junctions are kept low. Provision must also be made to handle the high leakage currents.

If transistors are to be used for the instrumentation of aircraft of the present and future, they must be used in circuits which will operate reliably at the highest permissible temperatures. Commonly, the junctions of germanium transistors must be kept below 95 C. It is the object of this article to show methods whereby germanium transistors may be made to deliver several watts at ambient temperatures as high as 90 C, only 5° below the maximum allowable junction temperatures.

A three-stage servo amplifier delivering 3 watts to a 400 cps motor will illustrate the methods. The design of this amplifier seems to present some particularly difficult problems since the transistors must be used efficiently if their junction dissipation is to be acceptably low and since this "linear circuit" has limitations on the methods which may be used to control the collector leakage current.

A servo amplifier should have the highest possible gain for a given number of transistors, a stable gain, operating points which are independent of temperature, high efficiency, and good reliability. All these are not achievable simultaneously. For example, the gain must be reduced from its maximum by feedback if it is to be stable, and efficiency must be sacrificed if the operating points are to be stabilized against variations in collector leakage current. Since this amplifier was to be used in aircraft, reliability, stability and efficiency were considered more important than the maximum gain per transistor. Therefore, the circuit has been designed to require a minimum number of solder joints, a minimum number of components of all types and only one transformer. These reductions in complexity and consequent increase in reliability also result in a reduced cost. Transistors are cheaper than miniature transformers.

*Defence Research Board, Ottawa.
†Link Aviation, Binghamton, N.Y.

The authors had a paper on this subject published in Electronic Design, Aug. 15, 1957 (Hayden Publishing Co., Inc.)

Designing for thermal stability

The temperature difference between the transistor junction and the ambient air must be kept to a minimum if the transistor is to operate at 90 C. This temperature difference is determined by the heat generated by dissipation at the collector junction and by the rate at which that heat may flow from the junction. Heat flow can be described by a network theory similar to that used for electric current flow. The basic relationship is:

$$\frac{\text{Temperature difference (°C)}}{\text{Heat flow (watts)}} = \text{Thermal resistance (°C/watt)}$$

Figure 1 shows a power transistor and a simplified thermal equivalent circuit. Since the thermal capacity at the junction itself is difficult to evaluate, the worst case —no thermal capacity—has been assumed. R_1 is the

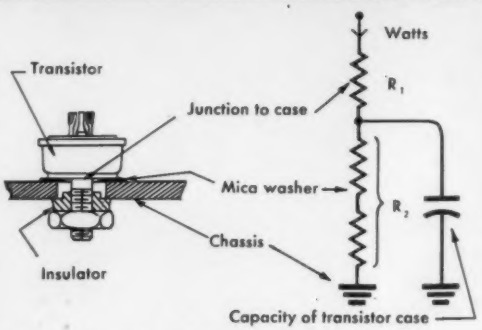


Fig. 1. Thermal path from junction to chassis. Thermal capacity at junction is hard to evaluate.

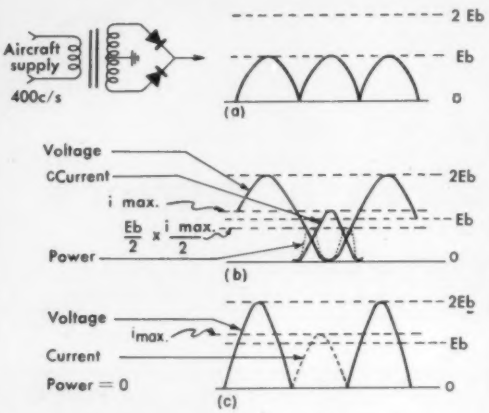


Fig. 2. Comparison between a dc and modulated supply for class B output stage at max. output (a) 400 cps unsmoothed, (b) collector waveforms, dc supply, (c) collector waveforms, modulated supply.

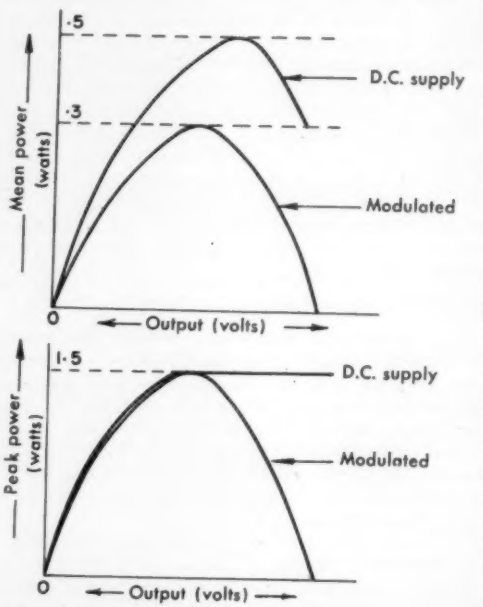


Fig. 3. Collector dissipation vs. output volts.

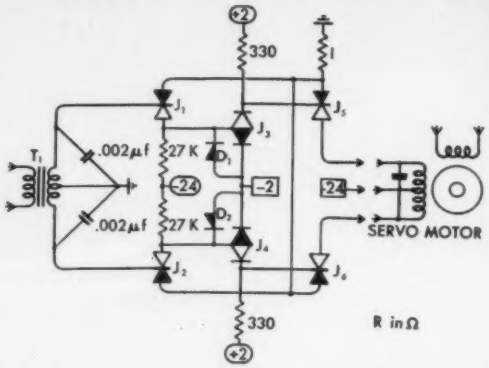


Fig. 4. Complete circuit of servo amplifier. Components used are: J_1, J_2-T.I. type 2N368; J_3, J_4-Hughes type HA 5002; J_5, J_6-Honeywell type H_6; D_1, D_2-IN98 with leakage less than 150 ua at 85 C; T_1-10k to 10k centre-tapped trans. Capacitors across T_1 prevent oscillation-value is not critical. Voltage in oval is pure dc or partly smoothed supply. Unsmoothed supply may be used at lower max. ambient. 24 in box is peak value from full wave, unsmoothed supply.

junction to case thermal resistance (2.2 C/watt for an H-6 Transistor), C is the heat capacity of the transistor case, and R_2 is the thermal resistance of a 2 mil mica washer and a typical chassis.

This equivalent circuit shows that the instantaneous junction temperature is dependent both on the peak and on the average dissipation, and that both must be kept low. A full wave rectified, but unsmoothed, voltage was used as collector supply for the class B servo amplifier because, as is shown in Figure 2, considerably less power is dissipated than if a smooth d.c. supply had been used. Ideally there is no dissipation at full output.

Figure 3 shows the collector dissipations for both types of supply over the full range of output voltage. If the values shown are substituted in a formula based on Fig. 1, then the maximum junction temperatures for the two supplies are:

(Mean power) x R_2 + (Peak power) x R_1

$\frac{1}{2}(1 + 3) + 1.5 \times 2.2 = 5.3$ C (d.c. supply)

$\frac{1}{3}(1 + 3) + 1.5 \times 2.2 = 4.6$ C (unsmoothed supply)

Some modern transistors have junction thermal time constants which are sufficiently high to allow the peak power, which must flow through R_1 to be reduced to the mean power, in this expression:

Then (Mean power) $(R_1 + R_2)$

$= 1/3\ (1 + 3 + 2.2) = 2.1$ C (unsmoothed supply).

Furthermore, not only is the unsmoothed supply simple to obtain but it is also not as subject to large transients as is the usual aircraft battery supply.

A second important problem in the design of circuits which are to be stable at high temperatures is that of i_{co}. The worst possible i_{co}'s—those occurring at 95 C—were calculated during the design of the servo amplifier. The circuit is arranged so that currents, always larger than the greatest i_{co}'s, are drained from each transistor whose operating point might be affected by the collector leakage currents. Then, at all temperatures below 95 C, leakage current alone cannot turn the transistors on.

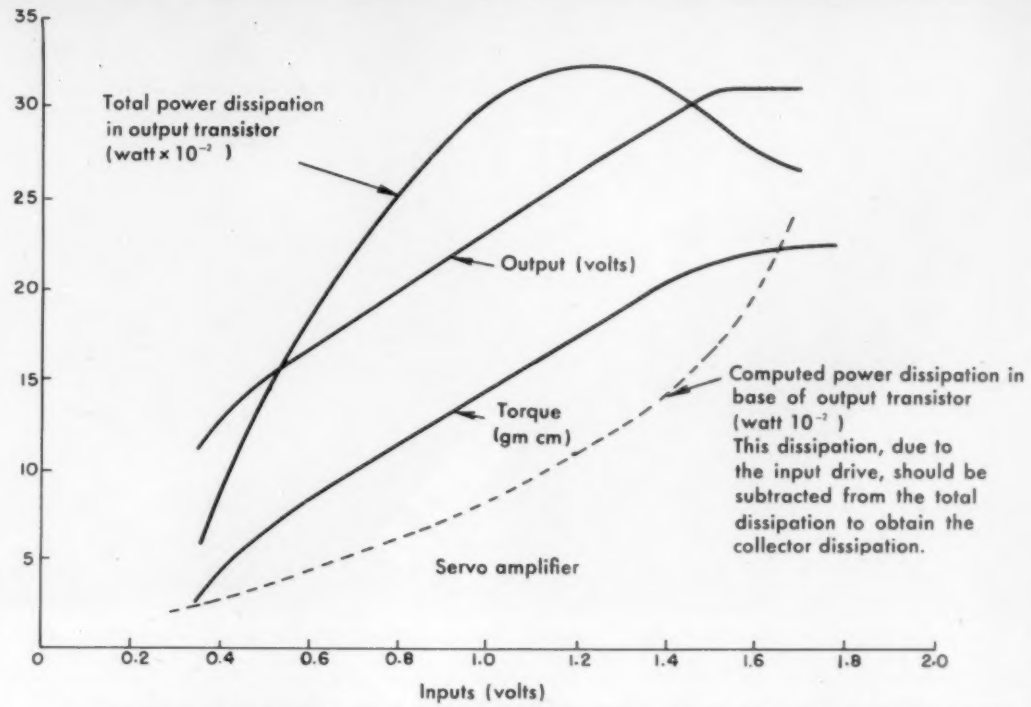


Fig. 5. These measurements were taken on an early model of the transistor servo amplifier using H2 transistors in the output stage, X2 transistors as drivers, and a 5 ohm feedback resistor.

Amplifier uses push-pull circuit

Figure 4 shows the complete push-pull circuit. The upper and lower halves are identical so reference will be made only to the upper half.

Alternate P-N-P and N-P-N transistors are directly coupled to make use of their complementary characteristics.

Negative feedback is provided by the one ohm resistor common to the emitter circuits of J_2, J_3, J_5, J_6 (both halves of the push-pull circuit since the two halves never conduct simultaneously) to stabilize the gain. This feedback raises the input impedance and stabilizes the voltage gain without affecting the current gain. A 1/3 volt peak input signal at the base of J_1 is sufficient to provide the 200 ma. maximum output current (130 mv has been allowed for the base to emitter drop across J_1).

This feedback is almost naturally stable since the loop circuit contains two common emitter connected transistors (J_2, J_5) with low frequency cut-offs and one common base connected transistor (J_3) with a much higher frequency limit. Hence, loop gain is reduced below unity at frequencies above 400 cps by J_2 and J_5 before J_3 can add appreciable phase shift.

Unsmoothed supplies are used as shown to reduce the collector dissipation in J_2 and J_5. The —2 volt peak supply at the emitter of J_2 is sufficient to keep this transistor from saturating before full power is delivered to the load and yet is low enough to keep the collector dissipation low.

It has been assumed that the maximum leakage current is less than 200 ua for J_3, less than 700 ua for J_2, and less than 5 ma for J_5. The 27,000 ohm resistor to —24 volts and the 300 ohm resistor to 2 volts drain away 0.9 and 6 ma respectively. This is always more than the total i_{co}'s which may flow into the resistors.

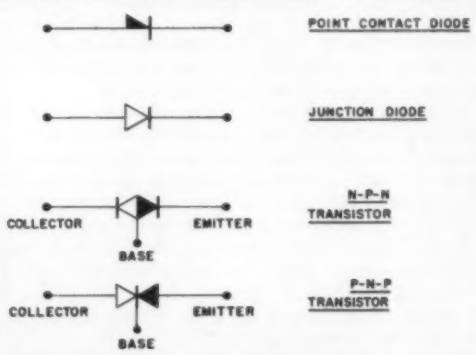
The diode D_1 prevents damage to J_3 from large reverse voltages across its emitter.

Tests prove reliability

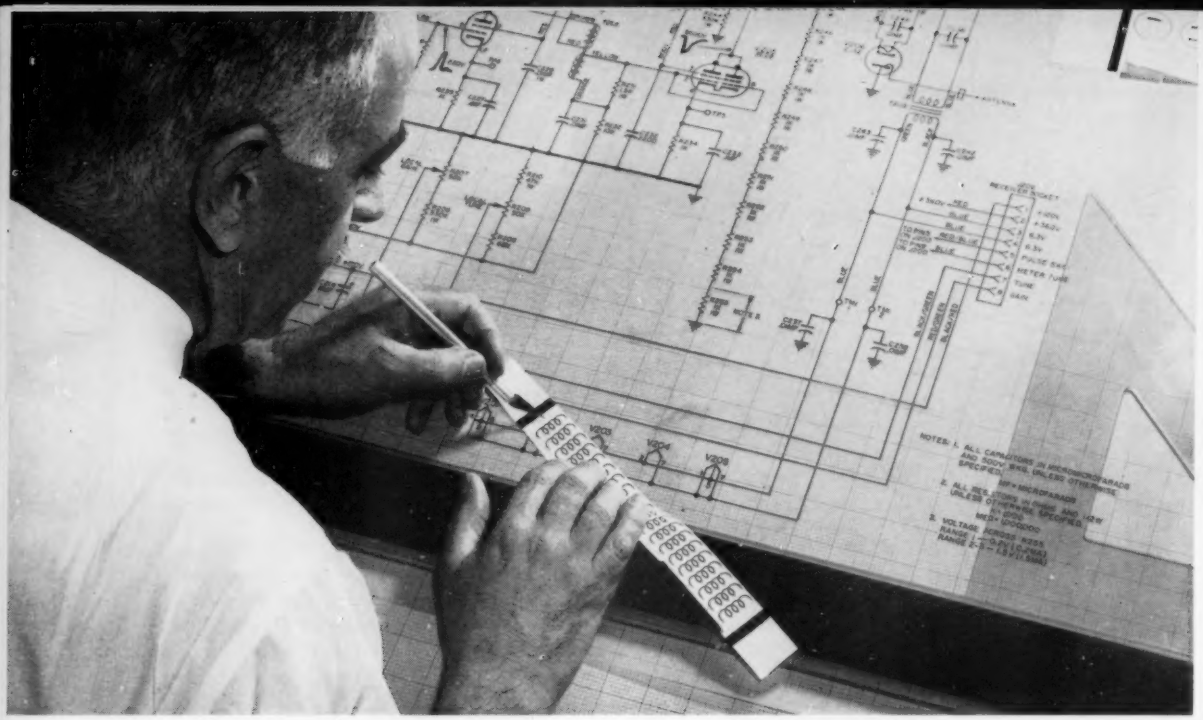
Measurements made on an earlier model of the amplifier which had a 5 ohm feedback resistor are shown in Fig. 5. The results agree well with the calculations and it should be recalled that the 5 ohm resistor requires a peak input of 1 volt to provide full output current.

Several of the amplifiers have been in use for the past three years and there have been no failures.

The photograph shows the complete amplifier. Care has been taken in the layout to reduce to a minimum capacitive coupling from output to input since high frequency oscillation might have occurred. END



Transistor and diode symbols used in the schematic



New tools and techniques improve drafting production

J. R. SIMPSON*

Tests show that top quality schematics made with printed acetate symbols, ink lines and washed-off linen cost less than free-hand pencil drawings. Most companies don't believe this because they haven't kept up-to-date with drafting techniques

Few people would argue with the statement that the schematic diagram, in the broad sense, is the most important single drawing associated with a given piece of electronic equipment. Unlike the symbolic drawings used in other fields of engineering, the electronic schematic has a practical, as well as theoretical, application.

Within the manufacturing organization, the schematic is involved in every operation carried out on the equipment, from the formulation of basic design, through production and testing, to installation and maintenance. More important perhaps (and in this respect the schematic differs from other drawings) is its use by groups external to the manufacturing organization; the number of schematics being drawn which are not ultimately applied by military or commercial agencies is steadily decreasing. This external application adds to the functions of the schematic the aspect of training.

In practice, the internal and external applications impose quite different requirements on the drawing. Schematics for internal use need not meet any rigid standards in terms of appearance, layout, or component designation; the principal requirement may be called durability, with this general term implying ease of erasure, cleaning and change, and ability to withstand handling. In addition to these characteristics, schematics for external use should reflect good preparation practices, e.g., consistency of symbol representation and lettering, clean, straightforward layout, reasonable proportion and complete component designation. If the user agency is military, these requirements become mandatory. If the drawing is to be used by a commercial customer, it can be, at the very least, good or bad advertising.

The clear-cut operational distinction made above between the two general categories of schematic is something of an oversimplification; "internal" schematics have a nasty habit of suddenly becoming important externally. Conversely, schematics which meet "external" standards can save a great deal of time and trouble within the organization, not to mention substantial quantities of the publications supervisor's hair. Obviously, if the manufacturer's drafting activity produced schematics to external standards in all cases, everyone would be happy. This state of affairs is rarely encountered—in many cases the schematic not only does not meet even reasonable internal standards, it is the worst prepared of all the drawings

*Electronic Associates Limited, Willowdale, Ontario.

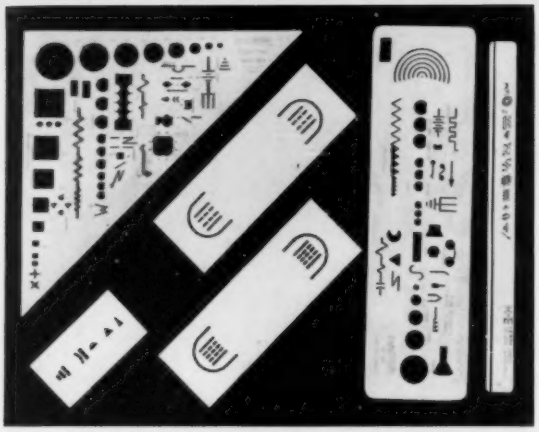


Fig. 1. Templates help produce good schematic symbols. At right is Leroy guide. Others are commercial and special guides cut in plastic; they work best with pencil

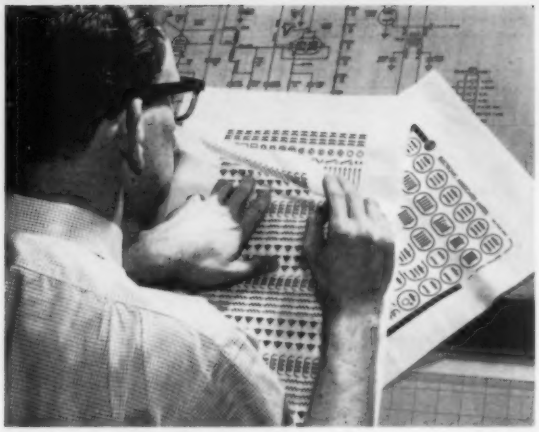


Fig. 2. Symbols printed on acetate with wax backing give uniformity with speed. Electronic Associates' symbols are only ones on market that comply with Canadian standards

associated with the equipment.

There are extenuating circumstances here which should be considered before we start castigating the drafting supervisor. A piece of equipment which has one schematic may require several hundred, or even several thousand, other types of drawing, and the emphasis in the drawing office must therefore be placed on having people who are primarily trained to meet mechanical drafting standards. Given sufficient time, any drafting activity can produce good schematics. Alternatively, given a sufficient number of schematics to do, the activity can maintain the services of a specialist in the field. Either of these conditions is rare, and the drafting supervisor must make do by applying techniques with which his people are familiar, but which may not always be the best for purposes of the schematic.

Since the drafting personnel are used to working in the media of pencil and paper, this is the most common type of schematic. The materials are relatively inexpensive, and the drawing may be easily changed. Its most serious disadvantage is in the area of durability; the pencil-on-paper schematic may be a thing of beauty when it comes off the board, but the chances are very good that after a number of changes are made and several prints are run, the drawing will be dirty, creased or even torn, and well-nigh incomprehensible.

Ink on linen drawings are expensive

The most expensive type of schematic, and therefore the least common, is the ink-on-linen variety. Almost by definition, it involves mechanical lettering of some sort, and may require other techniques with which the drafting staff is not familiar. Even if they are, such a drawing takes more time to produce, and the materials are more expensive. The ink-on-linen drawing offers a substantial number of advantages, however, among them much greater durability, negligible chance of accidental erasure of information, and improved legibility. In addition, the drawing can be easily cleaned when it gets dirty.

The general feeling seems to be that the difference in cost between the two methods is not warranted, and that even if the schematic is in fact used more than other drawings, conventional techniques and materials should still be applied. After all, you don't make anything from the schematic, and as long as the circuitry involved is barely understandable, everything in fine. There are several excellent arguments in favor of the additional cost, the best of which is probably the general level of engineering eye-strain, but being hesitant about undertaking such a massive educational program, we will confine this discussion to the premise that additional cost is not necessary, and that ink-on-linen standards can be met on a pencil-on-paper budget. Well, very close to it anyway.

There have been a number of developments in the fields of drafting aids and reproduction methods which make this possible, and which may not have been sufficiently explored. We must ignore questions of layout and drawing organization—these subjects would justify several individual articles—and restrict ourselves to the mechanics of producing the master file drawing. We will consider the field of reproduction methods first, since in some cases the preparation of the original drawing is affected by these methods.

It was pointed out that the principal difference between the pencil-on-paper and ink-on-linen types of drawing is durability, assuming that the drawings are equivalent in terms of layout, spacing, lettering, etc. There are in current use a number of processes which permit the transfer of a drawing from paper to linen, plastics, or specially treated papers. Among those which provide reproduction linens are the diazotype process, the so-called "wash-off" process, and several projection processes which involve photography.

The diazotype process is a direct contact one which requires no intermediate, or negative, and is the least expensive. The linen reproduction is made in exactly the same way that a whiteprint is obtained, and some elements of the sensitizing compound remain on the linen after processing. This, in addition to the fact that most of the available linens are plasticized to give them a smooth surface, can create a problem in ink retention when changes must be made. Careful erasure (by conventional methods) is important with this type of reproduction. The aging characteristics of diazo linens are good, and the fading which is often a characteristic of reproductions of this sort on paper does not occur. A wide range of control is possible during processing, so that dirt on the original can be removed with proper exposure.

The "wash-off" type of linen reproduction is more expensive, and involves a contact negative stage. The result, however, not only equals but excels an original ink-on-linen drawing. It may be erased using normal methods, or by the application of a moistened rubber eraser. The name "wash-off" refers to a step in the processing—the linen is in fact completely waterproof, one big advantage over ordinary linen. If extensive changes are envisaged

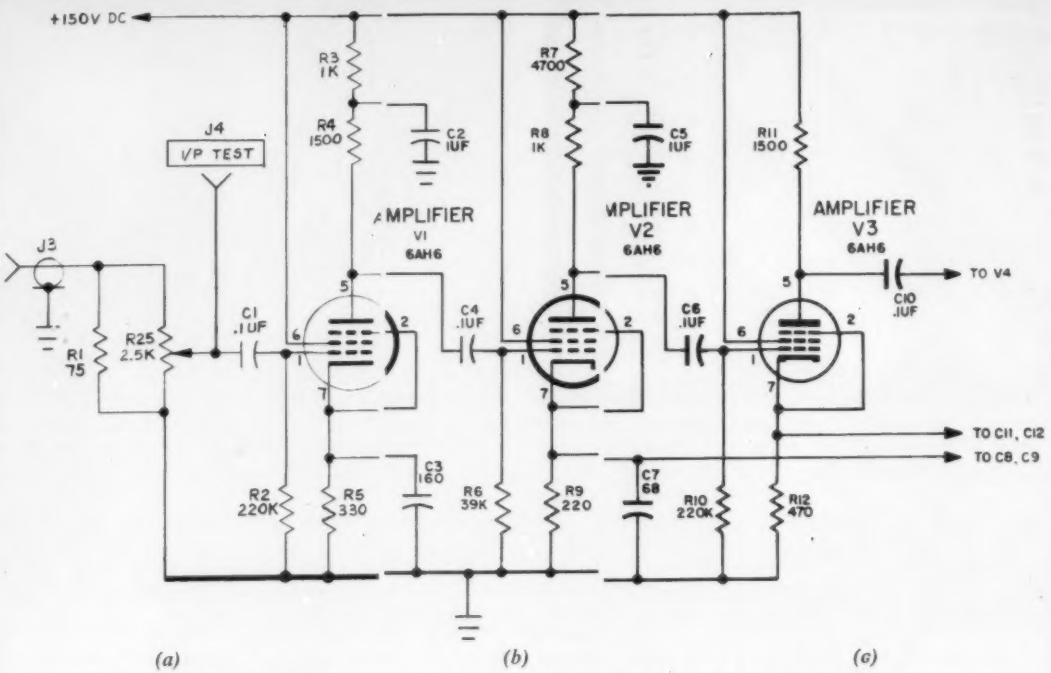


Fig. 3. This schematic was prepared by three methods for test, then composite engraving made. (a) Pencil on vellum using templates: 45 min. (b) Ink on linen using templates: 85 min. (c) Printed symbols, ink lines, wash-off linen: 45 min. B and C have comparable quality but C proves that good drawings can be produced economically.

this type of reproduction is highly recommended, since removal of the image by the moistened eraser leaves an undamaged working surface. Aging characteristics are excellent, and the linen is as flexible as ordinary tracing cloth because all the unexposed emulsion is removed during processing.

Projection types of reproduction are more expensive still, but they permit enlargement or reduction from original size. Like diazo linens, they retain emulsion, and are therefore slightly less flexible than the "wash-off" type. Ink retention and erasibility are good, and the drawing will not fade.

It is possible, then to solve the durability problem of pencil-on-paper schematics by having a linen reproduction made as soon as the original is drawn. The cost varies from $3.60 to $12.00 for a D-size drawing, depending upon the process used. This cost is small in relation to the advantages obtained, but in order to remain within our pencil-on-paper budget, we must somehow recover the reproduction cost in the course of preparing the original. Fortunately, the methods used to save preparation time also produce better drawings, so that making the schematic more durable doesn't only perpetuate a multitude of sins.

Acetate symbols can reduce drawing cost

A large proportion of the time required to draw a schematic is spent on symbol representation. The slowest possible method of drawing symbols involves the use of conventional drafting instruments, yet compasses, for example, are still used to construct coils, tubes and other circular elements, and even capacitors, in some drafting offices. One logical development, in view of the repetition of identical symbols and the relatively small total number of symbols involved, is the template. Many different types of template for electronic symbols have been evolved; some are shown in Fig. 1. For many of the symbols, these are very successful; resistors and capacitors, for instance, may be drawn quickly and accurately. Some of the more complex symbols, e.g., tubes, present a problem because they involve totally enclosed areas which are mechanically impossible to provide on a template. Such structures must be built up in two or more steps, but the template method is still faster than the conventional procedure, and it provides reasonably consistent results from symbol to symbol. Most templates can be used for both pencil and ink work, although the latter is sometimes awkward unless special provision is made for keeping the template off the drawing surface.

Among the more sophisticated developments in the field of aids for symbol representation are stamps, magnetic blocks, and pre-printed acetate symbols. The first of these necessitates the use of ink, which may not be desirable. Magnetic blocks are ideal for very high-volume enterprises in which quality is essential, but they involve the use of ancillary photographic equipment which is usually not available, and require high initial expenditure. It is the last-mentioned process above, the use of pre-printed symbols, which is worthy of detailed consideration, since it involves nothing more than the ability to cut pieces from a sheet and stick them on another sheet.

The basic principle of the pre-printed symbol process is the reproduction (usually letterpress printing) of high definition symbols on very thin acetate which is subsequently waxed using a combination of beeswax and paraffin. The desired symbol is applied to the base material, interconnecting lines are drawn, and the necessary lettering done. Representative sheets of such symbols are

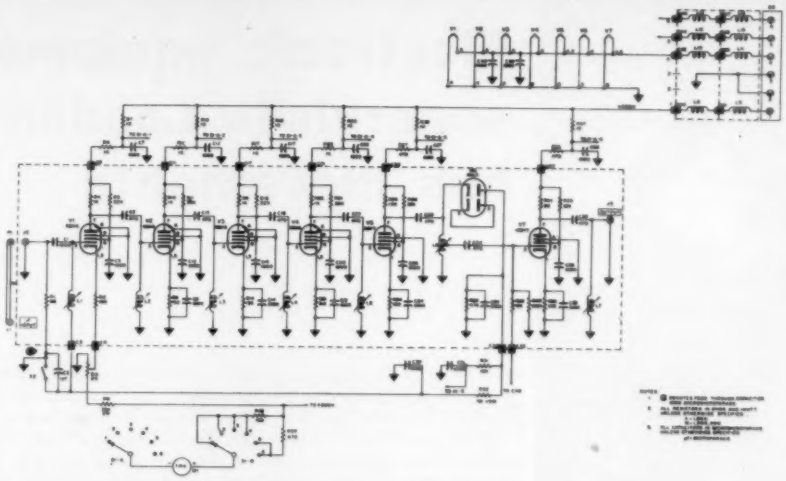


Fig. 4. Clean drawings are necessary if reduction is to be made in printing. This is severe test to ⅛ original size

shown in Fig. 2; these were specifically prepared to conform to Canadian Government Specifications Board requirements, but there are various other types available, notably those produced by "Artype." There is nothing particularly new about printed symbols, but they have not been used as widely as might be expected. Everyone seems to agree that they are a good idea, but some superficial objections have been raised without adequate research being done into the techniques which can make them practicable. Perhaps temperament has had something to do with it too—draftsmen take the same exception to cutting things out and sticking them down that they took to mechanical lettering devices many years ago. It may not be drafting in the accepted sense, but it's progress just the same.

The two principal objections to the use of these symbols are (a) that the original drawing is not a satisfactory master, and (b) that the drawing of an ink or pencil line from the symbol to the base material is difficult. Both of these objections are valid, the first because the symbols can conceivably move when subjected to high temperatures in blueprinting machines, and the second because an ink line tends to run along the waxed edge of the symbol, and a pencil line will not take on the acetate at all. Both objections can be overcome in one fell swoop by doing the original drawing on a throw-away basis and using one of the reproduction methods discussed above.

By using the symbols sufficient time can be saved to more than compensate for the reproduction cost.

Test proves advantages of new drawing techniques

Fig. 3 illustrates three methods used to produce the same drawing. Fig. 3(a) is a conventional pencil-on-paper drawing, executed by means of templates, and hand lettered. It is quite adequate in terms of presentation, but is not durable. Fig. 3(b) is at the other extreme; it was done in ink on linen, using templates, and is durable but expensive—the time required was doubled. The third schematic was done using pre-printed symbols on the same paper used for Fig. 3(a), and a "wash-off" linen reproduction made. Since contact reproduction processes will not distinguish between differing line densities, the symbols may be placed on the front of the tracing paper, and the lines drawn on the back. The problem of line transition from symbol to paper is thus overcome. A covering of 8 x 8-to-the-inch grid paper on the board speeds up the symbol positioning process, and they may be lightly tapped into place until the spacing and general layout has been checked, then firmly rubbed to prevent movement. Fig. 3(c) was produced in the same time as the pencil-on-paper drawing, and this time included mechanical lettering. Actually, the "wash-off" linen version cost $1.35 more than the pencil-on-paper drawing, this amount being the reproduction cost. Because of space limitations, the examples given here are small in size; the saving in time when printed symbols are used increases in direct proportion to the size of the drawing. With very little practice the average draftsman can produce a D-size drawing similar to Fig. 3(c) for the cost of pencil-on-paper original, and at larger sizes a tangible saving can be realized. On a group of recently prepared 44 in. x 108 in. schematics, 40% of the time which would have been required for ink-on-linen originals, and about 20% of pencil-on-paper time, was saved by using this method.

The connecting lines and lettering for Fig. 3(c) were done in ink, but careful pencil work, using an H pencil, can also produce good results.

Fig. 4 is an example of the difference which consistent symbol representation can make in a drawing, and is primarily applicable to the "external" use of schematics discussed earlier. This i-f amplifier was done in the same way as Fig. 3(c), except that the reproduction linen was made by the diazotype process. The original is 24 in. x 39 in., and Fig. 4 is therefore about one-eighth original size, but is still readable. This is the characteristic of a schematic which prevents a storm of invective from the publications section when an instruction book must be prepared.

It is difficult to assess accurately the amount of time and trouble saved within the organization when the schematic receives the consideration it deserves; in some cases actual errors in production have been caused by schematics which became dirty or partially obliterated through handling. It is less difficult to assess reaction when the drawing is used outside the organization—ask the customer relations people.

The examples of schematic technique given here are limited in scope, and the cost comparisons are certainly not conclusive. They should indicate, however, that good drawings can be produced at much less initial cost than has generally been assumed, and that over the term of an average project the saving can be substantial. END

Electronic equipment supervises London bus movements

The only equipment needed on bus is a plate fitted with reflectors for coding (top row) and for timing (lower row)

With 7,000 buses operating on 500 routes, the London Transport Executive faces a major schedule control problem. They are now using electronic scanning equipment at check points to read binary codes (reflectors) on the buses. The information is then transmitted by wire to a central control

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The new London Transport supervisory system informs a central office when a particular bus has passed a certain selected location on its route. Electronic equipment installed at a control point reads the bus number and transmits it over telephone wires to an illuminated panel at the central control point. Small reflectors on all vehicles provide identification. The bus number is put into binary code, which is reproduced on a plate.

Scanning equipment fitted on the route focuses a light beam on the bus plate. A photo-transistor receives impulses from reflections from the bus plate as the bus passes the scanning location. Current pulses depend on the binary code representation of the bus numbers.

In order to allow for different vertical positions of the bus reflector plates the reflectors are arranged in pairs. Provision is also made for varying bus speeds. A special identifying frequency eliminates interference. Each check point is linked to a display panel at the control centre. As a bus passes a check point the corresponding lamp on the panel is illuminated. With several panels in the control room the movement of a bus can be supervised.

A general diagram of the system is shown in Fig. 1. The telephone lines linking the check point equipment to the control centre are for the most part London Transport private lines, notably those on their railway system. Otherwise the lines to the scanning points would be the largest financial obstacle to the scheme.

At each check point scanning equipment must be installed at each side of the road to register the flow of buses. Moreover the scanner unit must be mounted so that the buses pass within about 12 ft. of it—above this distance the angular displacement of the light becomes increasingly difficult to accommodate. In addition, if the spacing from the curb becomes too great, there is the danger of a parked lorry completely masking the scanner. Sites chosen, therefore, are places where the road is narrow, or its width restricted due to a pedestrian island. As the scanner unit itself may need to be pole mounted, it has been made as small and as light as possible. When it is mounted in this manner the relays and other equipment must be mounted at suitable positions, either in a building or in a street box on the sidewalk.

Fig. 2 is a diagram of the scanning unit. It will be seen that only one lamp is used and the two beams for time-base and code number, are obtained by a system of mirrors. The 3,000 cps identification is impressed by passing the light through the peripheral slots of a rotating disc chopper.

The light reflected from the bus plates is passed into the scanner once more and focused onto two photo-sensitive transistors. These transform the light impulses into electrical impulses. The electrical signals enter frequency selective amplifiers that reject impulses due to extraneous light not associated with that of the instrument's lamp

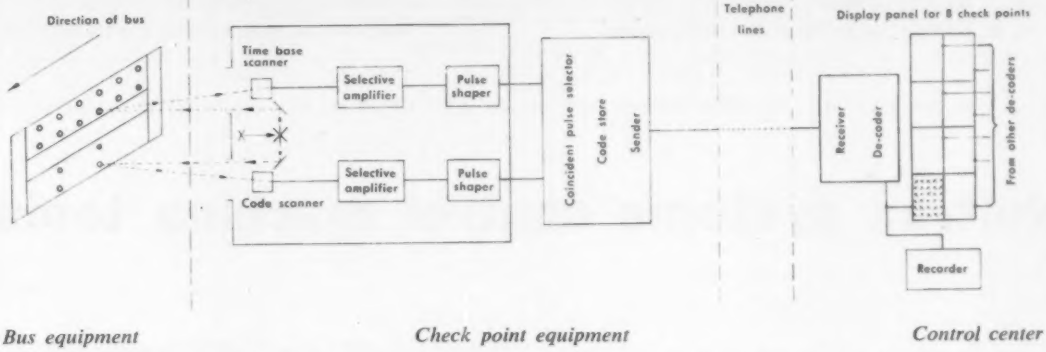

Fig. 1. Modulated light from check point equipment reflects off code buttons on bus, back to code scanner. Pulses sent to control centre via telephone lines enter display panel in front of supervisor.

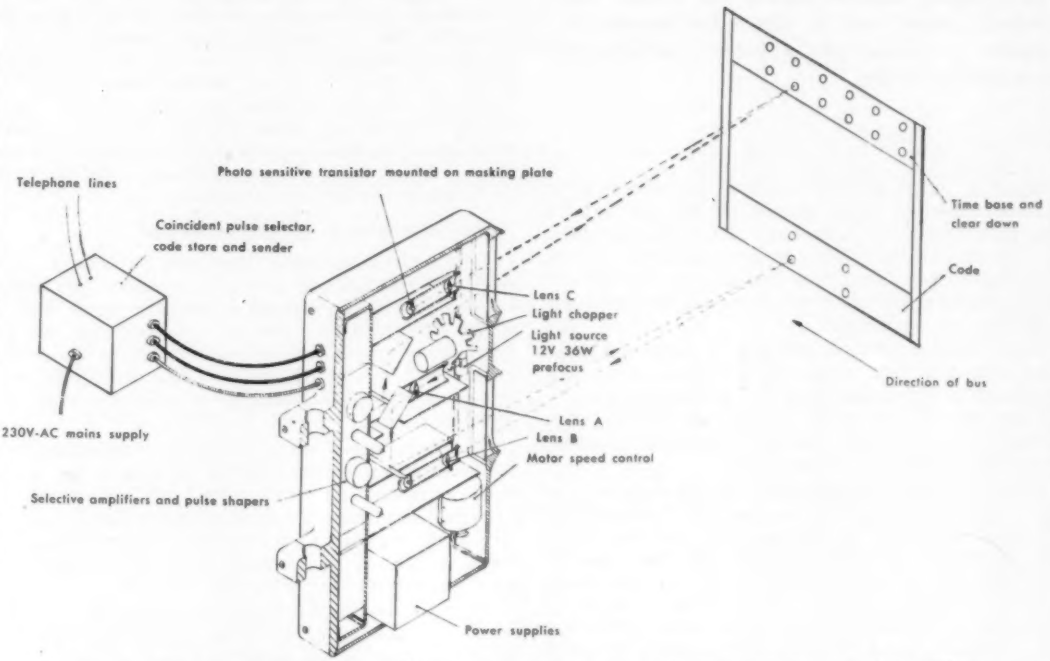

Fig. 2. This is the physical arrangement of the light source, chopper, transistors and amplifiers.

at the controlled frequency. Since the wave-form of the 3,000 cps signal impressed with the bus identification code cannot operate the telephone relays in the equipment that follows, the signals from the amplifiers are passed through pulse-shaping transformers that give a square pulse from each reflector signal. The pulses from the time-base plate are then paired with those of the code plate by feeding them to cold-cathode tubes, and when both time-base and code-cathode tubes fire together, relays are operated and the code is stored.

Storing is necessary since at least two scanners—and possibly more in busy traffic centres—have to share the telephone line to the control centre. The relays storing the code are released in turn over the line, giving pulses similar to those associated with the dialing of a normal telephone. There is little technical novelty in the circuit used at the control centre. The stored binary number at the scanning point is fed into the line, as soon as a clear channel is available, by normal pulsing procedure. The pulses are stored in a similar manner by relays at the centre and, when built up, energize the lamp carrying the running number corresponding to the code. In addition, a pen recorder can form a permanent record of the time each bus enters the section and hence indicate the regularity of service. The whole of the equipment has been designed and developed at the London Transport Executive's Electrical Section at Wood Lane, London W.12, under the direction of Mr. T. S. Pick, the Chief Electrical Engineer. END

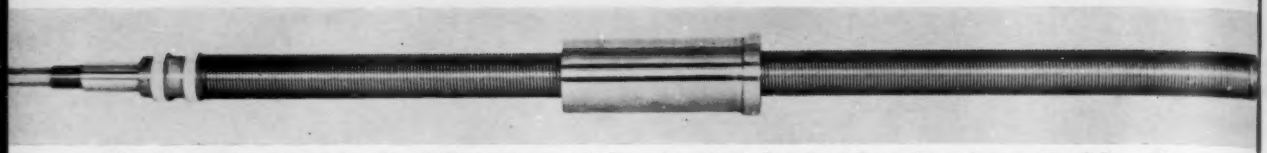

Fig. 1. Nultrax transducer has bifilar primary windings in spiral thread of bar. Secondary is in sliding sleeve

Nultrax systems control machine tools

R. GUENETT*

Canadian Westinghouse Co. Ltd. has developed a new, rugged, long-life machine tool control. The Nultrax system uses a differential transformer position transducer with a possible accuracy of one part in 400,000.

Basic to any numerical machine tool system is an electrical indication of the position of the tool or table being controlled. This feed-back signal must be accurate for on it depends the entire system performance. Where the cutting tool is driven by a lead screw a data element may be geared to the screw which will provide this signal proportional to tool position.

Data elements may be classified as either analog or digital depending upon whether their output is continuous or in pulse or incremental form. A potentiometer is perhaps the best example of an analog data element while there are several magnetic and photo-electric pulse wheels available which provide a digital output.

In selecting a data element for a machine tool control system several considerations are involved. Accuracy as mentioned before must be in keeping with the desired system performance. Reliability and life expectancy must be in line with that of the machine tool itself. This means an element must be designed to last a minimum of ten years when the machine is used on a normal production basis. Standard analog elements may not meet this stringent life expectancy requirement, especially if any misalignment of parts takes place. Digital pulse wheels, though having a long life expectancy, have the limitation that pulses may be either lost or gained thus introducing an error which may go undetected unless non-ambiguity circuits are provided.

To avoid these limitations an analog data element has been developed which consists of a linear synchro connected up in a stepless switching arrangement. By utilizing the proven reliability of synchros this unit has a life expectancy in excess of the ten years mentioned above. No complex electronic circuits are involved and its resolution is in the order of one part in 400,000. Accuracy is better than one part in one thousandth of a revolution. To see what this means in a system consider a lead screw with a pitch of 0.25 inches. An accuracy of one part in 1,000 in the data element means an electrical signal with an accuracy of ±0.00025 inches. To this must be added errors in the screw itself which can be kept to a minimum by using precision ground ball screws.

For highest accuracy and performance it is desirable to eliminate the lead screw or other power linkage as a measuring link. In addition to any inaccuracies arising during its manufacture, dirt, wear and oil film compressibility all introduce errors. Several devices have been introduced which provide this measuring function. These include conventional optical gratings and other elements consisting of electrical circuits etched or imbedded in glass plates. All eliminate the short-comings of lead screws but are fragile by machine tool standards.

Nultrax is accurate to one part in 100,000

The Nultrax transducer, developed by Canadian Westinghouse, provides an extremely accurate yet rugged measuring link. In practice it translates linear displacements into equivalent electrical signals and thus acts as a linear position transducer. In its standard form it is accurate to one part in 100,000; to one part in 400,000 when properly calibrated. Repeatability of position is better than 50 micro inches.

A sixteen inch Nultrax transducer is shown in Fig 1. It consists of a long cylindrical bar and a sleeve free to slide along its length. In long lengths (units up to forty feet have been made) the sleeve is horseshoe shaped allowing the bar to be supported at its centre point. Although sag does not affect accuracy to any great extent, mechanical clearance may become a limiting factor.

The primary of the Nultrax is the cylindrical bar in which a two start spiral thread has been cut. Two fibreglass-insulated windings are placed in these grooves, joined together at one end and brought out to two slip rings at the other. This produces a long bifilar primary winding. The secondary sleeve contains a bifilar winding imbedded in its inner surface which has the same pitch and lead as the primary.

If the primary is excited with an ac voltage there is no external magnetic field around the bar as the winding is bifilar. However, each individual primary turn has a fringinal magnetic field surrounding it. A cross section of the transducer is shown in Fig. 2. Here alternate turns of the primary are carrying current in opposite directions.

Figure 2(a) shows the secondary sleeve positioned so its turns line up with those on the primary. Due to the fringing of the fields a voltage is induced in each secondary turn. The output of the secondary is now a maximum being the vector sum of the voltage induced in each turn. If the sleeve is displaced along the bar a distance equal to one half the winding pitch, Fig. 2(b), each secondary turn lies equidistant from the two associated primary turns. Under

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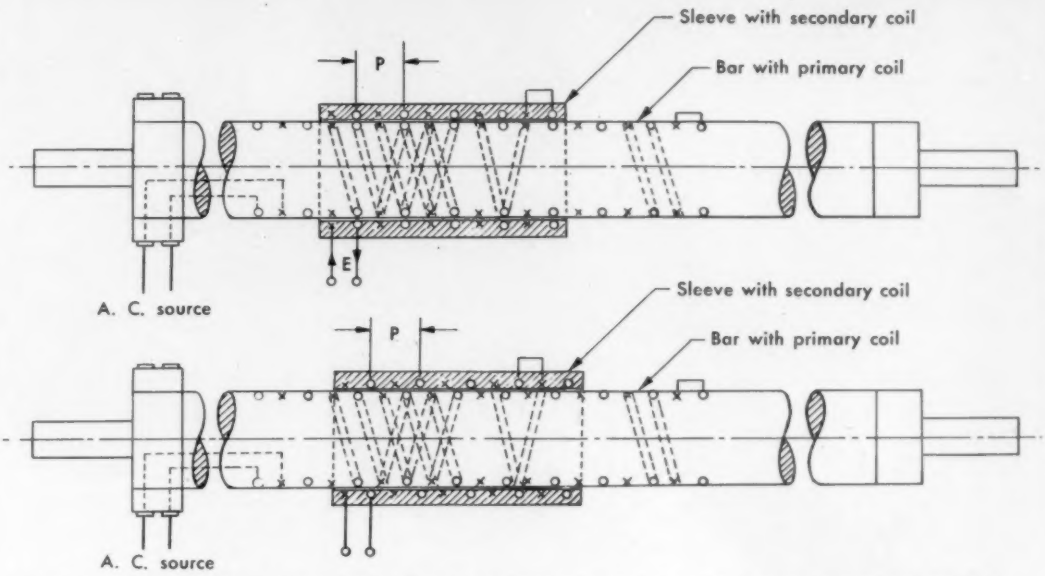

Fig. 2. Cross section of transducer shows: (a) secondary sleeve positioned so it turns align with primary, giving maximum voltage; (b) sleeve displaced to give zero voltage across secondary windings.

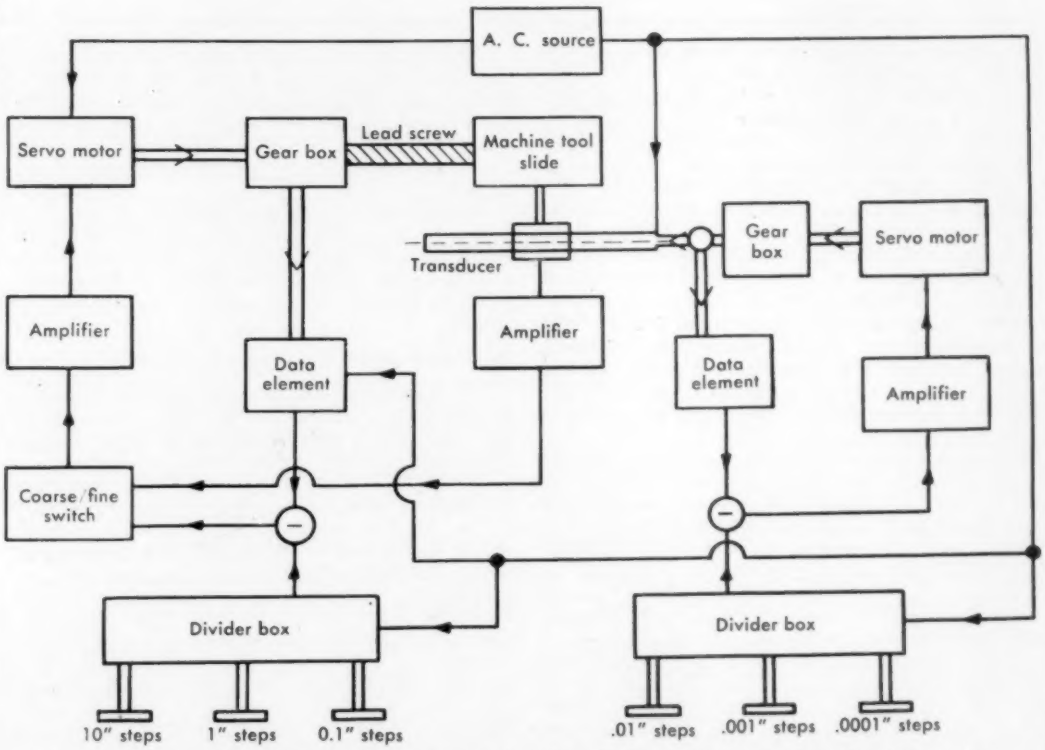

Fig. 3. Linear point-to-point positioning system has the widest application for machine tool control.

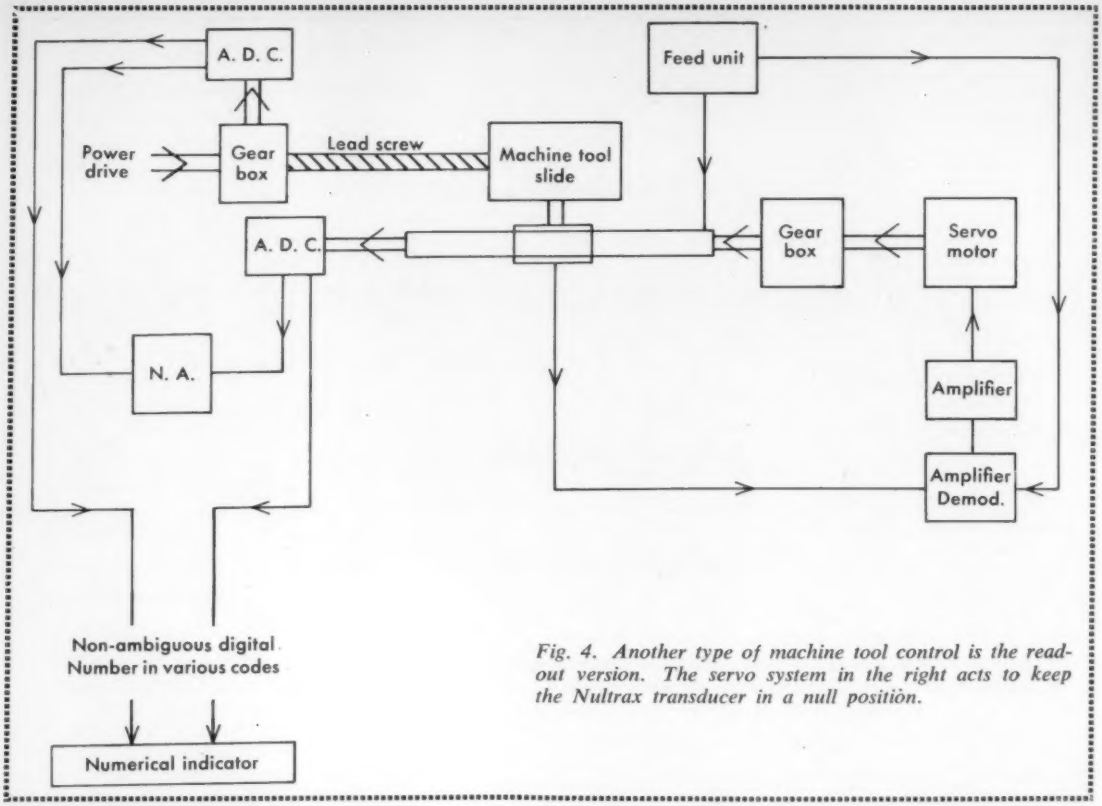

Fig. 4. Another type of machine tool control is the read-out version. The servo system in the right acts to keep the Nultrax transducer in a null position.

these conditions no voltage appears across the secondary terminals. Continuing to move the sleeve in the same direction results in the induced voltage again rising to a maximum but in the opposite phase. Thus, the output of the secondary is approximately a sinusoidal function of the relative position between the two elements. The period of this sine wave equals to the lead of the windings.

Around the zero or null points of this function the transducer acts as a differential transformer giving a phase sensitive output. If "P" inches represents the winding lead, the transducer will have stable null points at intervals of "P" inches. The longitudinal position of a null may be altered by rotating the primary bar. As an example, consider a lead of 0.1 inch. With a bifilar winding this means a pitch of 0.05 inch. A displacement of 0.001 inch can then be obtained by rotating the primary bar 1/100 of a revolution; a displacement of 0.0021 inch by rotating it 21/1000 of a revolution.

Besides a high degree of accuracy over long distances in a rugged form, the Nultrax design eliminates all possible sources of error but one. Local errors in the primary winding are averaged out to a negligible amount by the 60 to 100 turns in the secondary. This is in contrast to lead screws which may rest on high points. Errors in the secondary winding do not affect system accuracy since the sleeve is engaged in an identical manner at all positions along the primary bar. Eccentricity or misalignment of the sleeve do not affect the physical location of nulls which lie in a plane perpendicular to the longitudinal axis.

An accumulative error in the primary winding however is not eliminated by the inherent design. Two solutions are possible. First such errors can be held within acceptable limits by controlled grinding techniques. An easier solution is to calibrate the transducer and correct such errors electrically.

Temperature errors are usually of no consequence except where the transducer is being used under controlled environmental conditions. Where required, correction for errors due to temperature variation may be introduced by dialing in a simple electrical signal. Such a provision allows the bar to have any effective temperature coefficient.

In practice, the Nultrax is mounted parallel to power linkage of the machine with its secondary sleeve rigidly connected to the moving member. Though either member may be rotated to obtain fine positioning the primary bar is usually selected to be mounted in bearings and free to rotate.

Three main systems for machine tool control

Three principal systems are available for application to machine tools. Whether the Nultrax is used or whether a data element is geared directly to the power linkage depends entirely upon the performance required.

Although not the simplest, the linear point-to-point positioning system shown in Fig. 3 has the widest application. Here the command position is dialed in manually on the control panel or established from information provided by a punched tape or card. The error signal resulting from the difference between the coarse portion of the command signal and the feedback from the coarse data element geared to the power linkage is amplified and drives the slide until this voltage falls below a preset value. At this point the coarse/fine switch brings the fine system into play. Here, a separate instrument servo system rotates the Nultrax to place the desired null in the precise position corresponding to the command position. The error signal from the secondary sleeve then drives the slide to the final position.

The servo power drive shown is used only for low

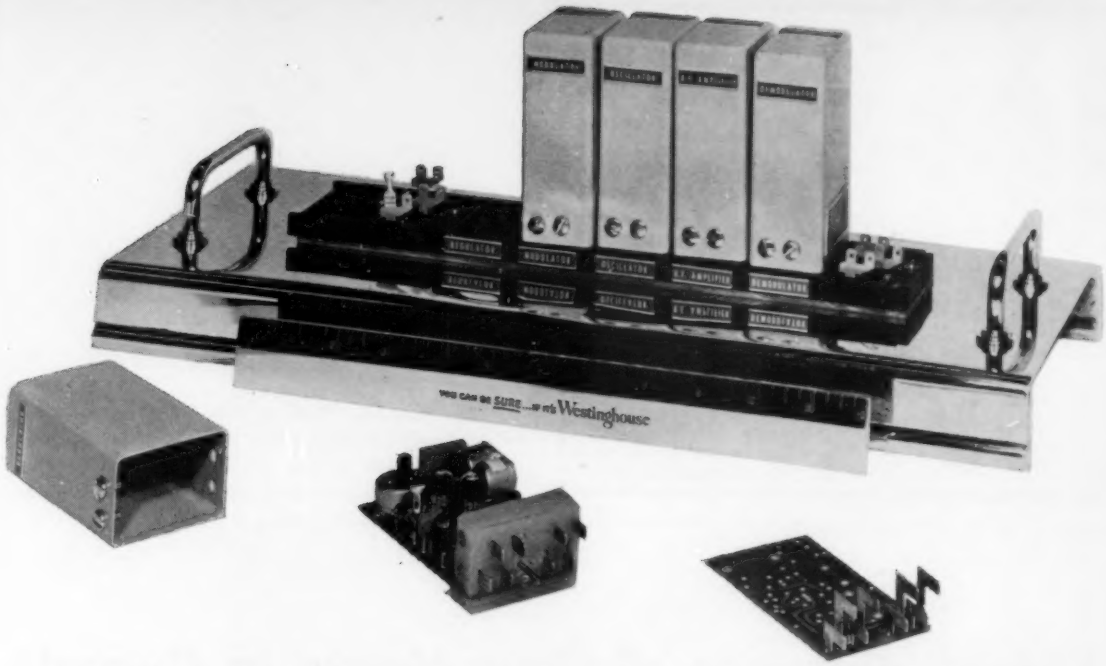

Fig. 5. Nultrax machine tool control systems use transistorized electronic circuits in modular plug-in form

power applications. Above ½ horsepower, conventional Ward Leonard type drives may be used with either rotating or magamp amplifiers. Another approach is conventional a-c motor drive with a clutch and brake arrangement. Exact choice of power drive depends upon the particular application.

An open loop version of the point-to-point positioning system feeds the error signal to a centre reading null meter forming a read-in measuring system. In this case the slide or tool is moved by conventional means.

Both read-in measuring and positioning systems can be simplified on certain applications where the power linkage is a lead screw. The Nultrax can be geared directly to the screw eliminating the instrument servo drive. Here the transducer is used to correct screw errors resulting from inaccuracies in the lead screw.

Another form of measuring system is a read-out version as shown in Fig. 4. The servo system on the right acts to keep the transducer in a null. As the machine tool slide is moved, thereby displacing the secondary sleeve, the primary of the transducer is rotated. An analog to digital converter (ADC) is attached to the Nultrax primary. A similar unit is geared to the lead screw. The outputs of these two are fed to a numerical indicator which provides a constant reading of slide position.

The most advanced form of numerical machine tool control lies in continuous path systems such as those used in contour milling. Here the Nultrax is used as a velocity servo and the path of the cutting tool continually guided along the path dictated by the command information read from a punched tape.

All of these systems outlined feature completely transistorized electronic circuits which are provided in plug-in modular form—Fig. 5. These provide a high degree of reliability together with ease of maintenance for minimum down time. Servo amplifiers are also transistorized and a 60-watt unit is shown in Fig. 6.

Components for the various systems have been standardized, allowing simpler versions to be converted to more advanced forms of control at a later date. This also simplifies the required inventory of spare parts where two or three different systems are in use.

At the present time, Canadian Westinghouse is equipping various machine tools with a complete range of systems at its Electronics Division in Hamilton. When completed this spring, these machines will allow Canadian and U. S. industry to evaluate these systems as they apply to their own particular production problems under actual operating conditions. It will be one of the only installations of its kind offered by a control manufacturer on this continent. Besides allowing industry to evaluate various systems, it will provide facilities for training production personnel in the correct application and use of numerical control.

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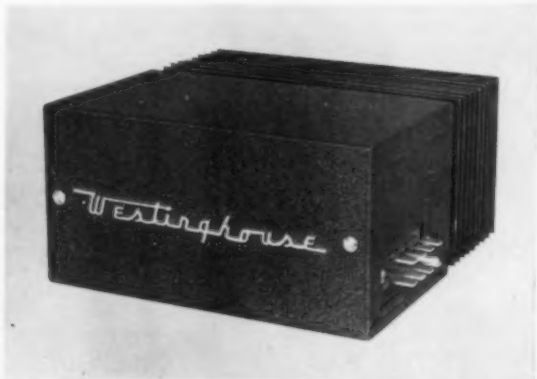


Fig. 6. Sixty watt transistorized servo amplifier

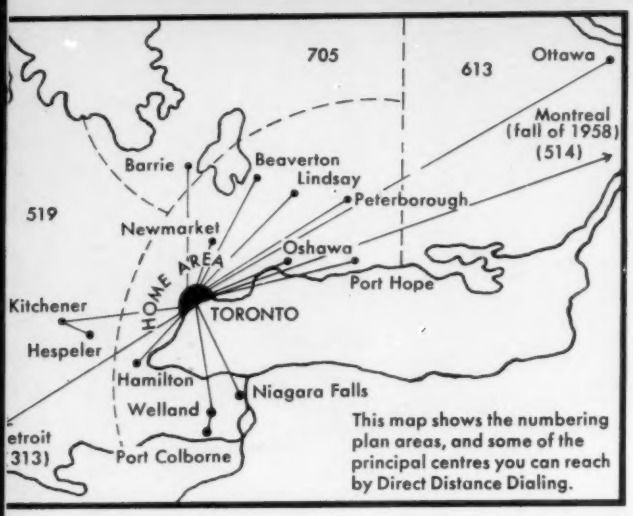


Fig. 1. This is the nucleus for DDD service in Canada

After May 25, telephone subscribers in the Toronto area will be able to dial their long distance calls directly. The service will be expanded to other areas as equipment becomes available and the traffic conditions make it economical.

Direct distance dialing starts in Canada

IAN R. DUTTON, Associate Editor

In the past 10 years long distance telephone traffic has almost doubled and will probably increase at a similar pace for several years. To handle the great volume of calls efficiently telephone companies have had to install large numbers of new switchboards and find enough girls to operate them. But the Bell Telephone Co. realized some time back that they would not be able to provide adequate service in the future without radical new methods of direct long distance traffic.

The first step was operator distance dialing. This enabled the operator in the originating centre to dial or key pulse a call direct to the distant telephone without needing any other operators en route. Within Quebec and Ontario more than half the long distance calls placed by customers have been connected in this way in recent months.

The next step is customer direct distance dialing (DDD). To achieve this Bell Telephone has been working steadily on new equipment and systems for continental U.S.A. and those parts of Canada which they serve. These include a continent-wide telephone numbering plan, a continent-wide long distance switching plan, automatic long distance switching or trunking equipment, multi-channel carrier transmission links and automatic message accounting equipment.

Each telephone number is unique

The map of Canada and the United States has been divided into more than 100 numbering plan areas, each designated by a 3-numeral code. Ontario, for example, is split into four areas and Quebec into three. With the progressive introduction of the 2-letter and 5-figure numbering system, each telephone number is being made unique within its own numbering plan area. The combination of area code and subscribers number makes each telephone number in the entire North American continent unique.

On May 25 direct distance dialing will be introduced in Toronto. The originating and completing fields planned for 1959 are shown in fig. 1. The completing field at cut-over will include most of these places. Montreal will be able to receive calls in the fall of 1958 as soon as it is entirely converted to 2-5 telephone numbers. The originating field at cut-over will include all Bell dial offices in the Toronto area except Bronte and Campbellville.

Centralized automatic message accounting equipment (CAMA) will be used in Toronto to record billing information. Because the Toronto area has 4A crossbar (4AXB) equipment the toll system is not quite fully automatic. When a customer dials a long distance call, an operator comes on the line and asks for the number of his telephone. She then key-pulses it into the equipment where the remainder of the accounting is automatic. The 4A crossbar equipment also makes it necessary for subscribers to dial a 3-digit access code (112 in the Toronto area) before dialing the area code and subscriber number. Areas with No. 5 crossbar (5XB) equipment are able to dial long distance calls without using the access code.

Guelph is scheduled to have direct distance dialing shortly after service is started in the Toronto area. Subscribers in Montreal will be able to receive calls in late 1958 but will not be able to originate DDB calls until the necessary equipment is brought into service in 1960. Plans also are under way to introduce the service in Valleyfield, Cornwall, London, Hamilton, North Bay, Quebec City and Ottawa within the next few years. The network will be continually extended and consolidated as equipment and

Fig. 2. U.S.A. and Canada are divided into more than 100 areas to make each phone number unique.

facilities are made available and as traffic conditions warrant.

This equipment makes DDD possible

To enable Toronto customers to dial their own long distance calls, crossbar tandem (XBT) equipment has been installed. Like all crossbar switching equipment, it consists of two parts. First there are the actual connections. Once a path is set up through these, they remain closed during the whole duration of the customer's conversation. There are also a number of pieces of equipment known as common control. These determine the route the call is to take and close the appropriate connections. Once they have performed this job they cut out of the circuit and are immediately ready to go to work on another call. A small group of common control units can set up connections for a large number of calls in a short time.

Centralized automatic message accounting (CAMA) equipment is associated with a crossbar tandem installation to record information necessary for billing customer-dialed long distance calls.

To speed up the long distance service, crossbar tandem equipment has a number of built-in features. Automatic alternate routing, if it finds that the direct route is busy, will try other routes until it finds one that is free. Initially two routes will be utilized in the Canadian equipment.

Dialed digits are stored as they arrive in the crossbar equipment which means that the information can be used for more than one purpose. It may be used to select a route, then some or all of the digits can be sent on to the next office to set up a connection there.

4A crossbar (4AXB) equipment has been installed in Toronto and Montreal. It has greater versatility than the crossbar tandem equipment but cannot, at the present time, be associated directly with automatic accounting equipment.

The Montreal and Toronto 4A installations are now used to handle operator-dialed long distance calls. They will also handle many inward and through customer-dialed long distance calls. For example the Toronto 4A will handle customer-dialed calls passed on to it by No. 5 crossbar office in Guelph. No. 5 crossbar (5XB) offices were primarily designed as local switching systems and they provide certain economies when used in medium-sized centres.

Toll charges are made automatically

Automatic message accounting equipment (AMA) keeps a record of all information needed for billing customer-dialed long distance calls. It records the information for each call on punched paper tape, then automatic billing machines complete the operation. When this service is performed for a number of offices at a central point, as in Toronto and Montreal, the billing information is recorded at the crossbar tandem switching centre instead of at each originating central office. CAMA is completely automatic except for the identification of the calling number. When a customer dials a long distance call, it is routed to a special CAMA operator. She comes in on the line to request the number of the telephone originating the call, then key pulses the information into the accounting equipment. Eventually, the calling number will be recorded automatically.

With some 60 million telephones in North America the creation of DDD has been a tremendous undertaking. But the engineers have failed to solve one major problem; how can you develop a human being that will always dial the numbers correctly? END

Radio engineers check progress and future of electronics in many fields

IAN R. DUTTON, ASSOCIATE EDITOR

Watch for some important announcements on controlled thermonuclear power in the next few months. With the British on the threshold of success, the Americans working hard and the Russians running a dark horse, the race is speeding up. We may find a winner this fall when scientists meet at Geneva for the second conference on Peaceful Uses of the Atom.

You can also expect increased participation by the electronics engineers. This was pointed out by E. W. Herold, Chairman of the Controlled Thermonuclear Power session at the IRE National Convention.

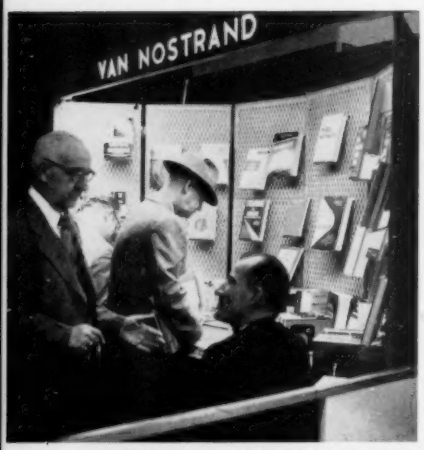
The atomic energy industry of today has been made possible by the skills and contributions of many groups . . . chemists, physicists, metalurgists, mechanical engineers and electrical engineers. The thermonuclear research, however, is being carried out primarily by physicists and electronics engineers.

Two of the major problems in achieving a controlled thermonuclear reaction are to heat the deuterium gas (at least to 10^8C) and then contain the plasma which would instantly vaporize any material which it touched.

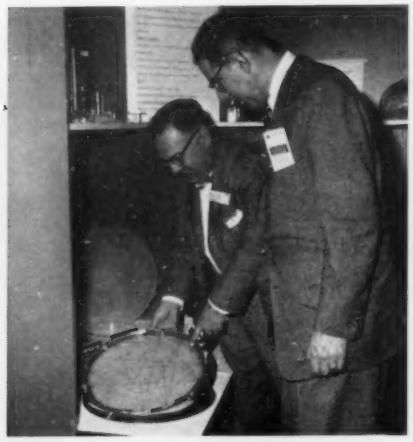
One method of heating the gas is by passing an electric current through it, but this must be induced, since electrodes would be vaporized. As the temperature increases, the resistivity of the ionized gas decreases, making it difficult to achieve ohmic heating.

Another method of heating the gas is to accelerate it to high speed, equal to the velocity achieved with about 15,000 electron volts. Some scientists have been combining the two methods.

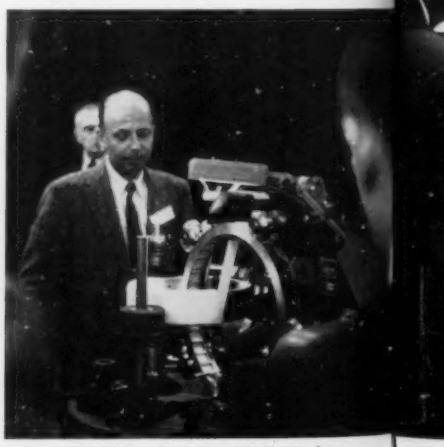
The hot plasma, made up of totally ionized gas, can be contained, at least for brief periods, by magnetic fields which pinch it into a thin stream. By the proper choice of these fields, a reasonably stable pinch effect can be achieved, holding the plasma in space away from the walls of the enclosing vessel. This is the technique being used by the British in their Zeta and Sceptre machines. In describing these experiments to scientists at the 1958 Nuclear Congress in Chicago (see report in April issue CEE) Sir George Thomson indicated that it would be possible to increase the size of the present British machines in the attempt to obtain sustained controlled thermonuclear reactions.



Publishers displayed latest technical books and magazines



Lines show transmission path through Amersil's 2778 usec delay line



Universal Mfg. Co. toroidal machine winds and tapes in one operation

An apparent contradiction was raised by Dr. M. Levine, another panel member at the IRE session on controlled thermonuclear power. Dr. Levine, credited with originating the pinch effect, doesn't think that this will lead to fusion. The fields required in a large scale working model would be very large. So far it has been impossible to approach this value without destroying the equipment with the large stresses set up in the coil windings.

Fields up to 1.6 x 10^6 gauss have been produced for very short durations in special structures. Attempts are being made to produce force-free coils in which there is equilibrium between the inner and outer magnetic forces. The high fields can melt and push away the metal or burn off the input leads.

Another panel member, Dr. Heald of Princeton University described some of the techniques of measuring the temperature and average confinement time of the plasma. Microwaves are used to measure noise in the plasma to determine temperature. Since several collective noises are present the real trick is to isolate noise caused by true thermal reactions. This, of course, is another area in which electronic engineers are making a major contribution towards controlled thermonuclear power.

In summing up the general field, Chairman Herold prophesied that if thermonuclear power becomes a reality the stations will probably be very large in power generating capacity. Energy will not be extracted in the form of heat as presently done but taken out directly as power by induction from the stream of charged particles. It may then become quite important to find new means of transmitting the power, such as direct radiation, to avoid losses caused by wire transmission.

Plasma may drive interplanetary rockets

To complete the session on thermonuclear power Prof. Bostick described work being done at Stevens Institute of Technology on Plasmas for propulsion. They have developed a plasma "gun" which generates a very small amount of plasma and ejects it at measured velocities of 10^7 cm/sec. Professor Bostick was quite elated on the morning of the session because they had just tested a new "gun" which showed every promise of achieving velocities of 10^8 cm/sec.

One objective of this work is to produce plasma guns for driving space craft. It probably would be necessary to start the vehicle by other means such as a rocket motor but once under way the plasma gun could provide the high velocities required for interplanetary travel.

It is probably safe to say that this session on controlled thermonuclear power was the most important session of the convention as far as the future work of electronics is concerned. Most of the other sessions dealt with present day problems rather than looking so far into the future.

Canadians present papers at the convention

Only a handful of Canadians presented papers at this year's National Convention. This isn't unusual and that is why it was quite gratifying to see one complete session devoted to the Canadian Automation System of Postal Operations. This was conducted by Dr. Maurice Levy, Technical Advisor to the Canadian Post Office, and his associates. They gave a progress report on experiments to handle large volumes of mail by using electronic sorters.

R. G. deBuda of Canadian General Electric Co. Ltd., Royce Works, described work he had done to establish new design criteria for low voltage windings of power transformers in the 20,000 to 200,000 Kva class. This dealt specifically with transportation of the windings to reduce eddy current losses.

At another session deBuda and J. Vilcans (also of CGE) teamed up to describe work on pulse transformers for modulators for ground radar and nuclear accelerators. To obtain a desired pulse shape, customers will specify values for risetime, droop, voltage, load and pulse duration. This paper described a method whereby manufacturers of transformers can determine if it is possible to design a pulse transformer to meet those specifications.

Eric Leaver of Electronic Associates Ltd., a recognized authority in his field, acted as chairman for the session on industrial electronics.

Wider use of semiconductors led to several displays of crystal pulling ovens. Above is NRC equipment booth

T. Goldsmith, Allen B. Du Mont Labs., drew interested group of engineers around his display of the storage crt

1958 IRE national convention

There was a marked increase this year in the number of sessions aimed at providing information on a subject to engineers from all other branches of electronics. It was interesting to note, too, that they drew the largest attendance. The reason behind this change in policy may well be due to the increased activity among the Professional Groups. At these meetings, held throughout the year, engineers with common problems can meet to compare notes. The National Convention could serve a better function as a meeting place for engineers to be brought up to date on all the major developments in the industry.

Needless to say the Russians provided the stimulus for some of the papers. Work on long-range radar systems, telemetering equipment, missile guidance systems, satellite tracking equipment, etc., was described.

To keep up with developments on the other side of the world, American scientists have been working on a machine that will automatically translate scientific Russian into English. This would help to bridge the large gap brought about by the lack of qualified translators. And the cost of developing such a machine will be insignificant compared to the amount of research which is known to have taken place in America and which could have been avoided, or at least reduced, by knowledge of work fully recorded in the Russian literature.

IBM has finally instilled its "Think" motto into a computer. Their latest electronic machine can read a magazine article and then write an abstract of it. Editors will greet this news with mixed reaction.

Missiles set pace for radio engineering show

The American missile program is the largest single field of development there at the present time and it certainly stood out at the show. Control equipment, telemetering equipment, inertial guidance systems, radar tracking equipment, environmental test facilities, new components and high temperature insulating materials on display all contributed to this effect.

Transistors are now well established components contributing towards reliability and miniaturization. Teflon, Mylar, ceramics and other materials were more plentiful this year. The move towards automatic assembly was also evident. Printed circuits, plug-in assemblies, soldering machines and other production machines of a semi-automatic nature were displayed.

The IRE Canadian convention keeps most of the Canadian exhibitors at home now but a few hardy types ventured into the Coliseum.

The Consolidated Mining & Smelting Co. of Canada Ltd. displayed their High Purity Indium which is approximately 99.999% pure. Cominco is one of the world's largest producers of the metal, having a potential production of 1 million oz per year. It is attaining greater importance in the electronics industry, being one of the metals used in semi-conductor devices. Indium is used to form p-n junctions with geranium in diodes,, transistors, power transistors and rectifiers. It is also useful as an indicator in atomic reactors since artificial radio activity is easily induced in the indium by neutrons of low energy.

Deposited carbon high stability resistors were shown at the booth of Constanta Company of Canada Limited. These products, developed by Mr. Bastanier, cover the range from 1/10 watt up to 2 watts.

After leading a team of U. K. scientific instrument manufacturers on a trade mission to Canada in early March, L. A. Woodhead, director, Cossor Instruments, went to New York to check on the latest developments in the electronics industry. Part of his time was spent at the Cossor (Canada) Ltd. booth discussing the products of his company with interested engineers.

A number of Canadian representatives went down to help their principals at the show. J. Root, E. Lomas, J. Knowles, B. Sheppard, D. Carroll and A. Sheffield were all seen in action. Undoubtedly there were others, but the Coliseum is a large place.

New products at the show

Sometimes you see a new idea and wonder why someone didn't think of it sooner. The Triplett Unimeter is a good example. The meter is built in two sections, one containing the movement with front cover, and the other containing the dial face and corresponding shunt. The two lock together quickly so that a number of meter combinations is possible from one standard movement

Lea of Marconi, left, tells about his new RD101 oscillator

Carrol, standing, and Sheffield from Ottawa helped out at TMC

E. Lomas checks Goodrich microwave absorber. He is the Canadian Rep

section plus several dial-component sections. This gives flexibility without the nuisance of multiple scales which are always hard to read.

The Amersil Company, Inc., New Jersey displayed an ultrasonic solid delay line having a delay time of 2778 microseconds. It was made of fused quartz. Oil in the new Helipot liquid-filled potentiometers is claimed to protect them from environmental damage. Most of the trouble comes from changes in temperature and humidity which will infiltrate regular potentiometers. This is counteracted by the oil filling.

Eitel-McCullough has developed a traveling wave tube for operation in the 4,000 to 7,000 mc range with a power output of 1 watt. Model X686 employs ceramic construction on the gun to simplify the assembly and obtain a rugged tube. Ceramics have also been used on their new line of reflex klystrons models 1K125CA and 1K125CB. These cover the frequency ranges of 3,700 to 4,400 mc and 4,400 to 5,000 mc. Output is 2 watts.

Mr. N. Lea of Marconi's Wireless Telegraph Co. Ltd. was on hand to demonstrate his quartz servo frequency standard. This employs a high precision 5 mc quartz crystal in combination with a servo system which eliminates the instabilities arising from the tubes and associated components. As the servo corrects errors in excess of a few parts in 10^{11}, the equipment provides the highest stability attainable with a quartz resonator.

Varian Associates announced the formation of a new division devoted to the manufacture of microwave components and custom built electronic equipment. This is the Radiation Division.

Microwave absorbing material looking very much like a thin sheet of rubber, was shown in action at the B. F. Goodrich booth. E. Lomas of Ottawa has just become the Canadian representative for these products.

The coming of the space age has increased the amount of instrumentation utilizing magnetic tapes. Protecting this tape from possible damage from spurious magnetic fields has been somewhat of a problem. Magnetic Shield Division of Perfection Mica has developed a number of special carrying cases for magnetic tapes designed to withstand a field of 2,500 gauss with a maximum of 1 db in tape level.

Of course, no show would be complete without some new audio equipment. Heath Company introduced their stereo system and their tape decks. Both these are in kit form and follow the general pattern of other Heathkits.

It pays to plan your display carefully

An interesting conversation was held with C. E. Pallas of Ivel Construction Corporation, a company that had designed and installed some 60 displays at the IRE show. We stood back and watched some of the displays to try and see what attracted the engineers. Good lighting has lots of drawing power. This is particularly important to Canadian radio people because the general lighting in the Automotive Building is not very good.

There should be some focal point in the display to catch the attention of people walking by. Typical of this "eye-catcher" was the spotlight at the Hoffman booth shining on a solar cell. When the light came on the cell provided energy to drive a small motor. When the light went off, the motor stopped. This sort of thing brings people into the booth but there must be something of genuine interest to hold them at that point.

Of course, it's fatal to tuck these interesting objects away in awkward corners. The first person in will be trapped by people behind him and traffic soon comes to a halt. This happened in several booths at the coliseum.

The final bit of advice for Canadians is to start your planning now. The IRE Canadian convention is very close at hand, October 8-10. END

American missile program set pace for many of the displays. Vanguard was at Martin booth

Mr. & Mrs. R. H. Tanner discuss Fellow awards with Mrs. Shank (r). Tanner is with Northern Electric, Belleville

The eyes and ears of our industry

U. S. Navy scientists have been using the moon as a radio relay station. Experiments at 200 mc and above indicate that many types of communication can be carried on via the moon. This official U. S. Navy photograph shows large radar antenna made by scooping 250-foot-wide hole in the earth

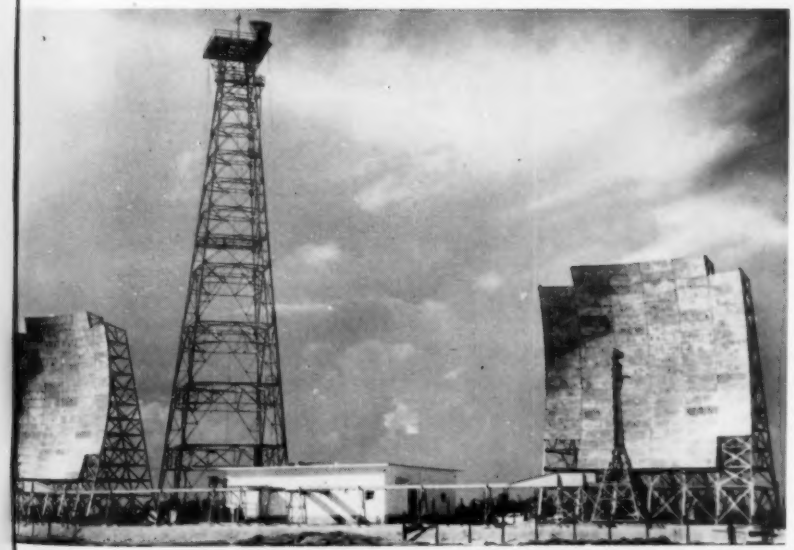
Transportable terminals are used by Collins Radio Co. to study tactical value of their tropo scatter equipment

Harvard University's 60-foot radio telescope antenna was designed and built by D. S. Kennedy & Company

Official U. S. Navy photo shows 600-inch radar telescope used by scientists to measure distance to moon

DEW line radar stations must be able to transmit information rapidly and accurately to defence command centres. The thirty-foot parabolic reflectors at the left were designed by Bell Telephone Laboratories engineers as part of the "over-the-horizon" radio transmission system.

Aluminum Co. of Can. supplied metal for 100-foot tower carrying IGY weather instruments at Resolute Bay



These sixty-foot parabolic antennas installed by IT&T Long Lines can carry more than 200 telephone circuits or two television programs in each direction. This is part of an over-the-horizon transmission link for commercial use

Slim tower and antenna is used by the Compagnie Generale De T.S.F. at Mont Pilat transmission station

For your library

Linear passive network synthesis for electronic engineers

Synthesis of Passive Networks

Ernest A. Guillemin. John Wiley & Sons, Inc., New York; 741 pp; $15.

Reviewed by: E. L. R. Webb, Radio and Electrical Engineering Division, National Research Council.

This is not a book for beginners, nor is it one for a man in a hurry. However, given the time and opportunity the mastery of this work would be a rewarding experience for anyone concerned with the dynamics of lumped linear systems. The adjective linear is emphasized because it is a sobering fact that even today we need better mathematical tools to cope with any but mildly nonlinear systems.

The first of Professor Guillemin's works (Communication Networks, Vols. I & II) was written a generation ago. More recently there has appeared a new series of related volumes in which Synthesis of Passive Networks, being the third, leans heavily on the first, Mathematics of Circuit Analysis, and the second, Introductory Circuit Theory. All are essentially teaching books, and stem from a program at M.I.T. of keeping textbooks on electrical communications abreast of the times. They should not be considered as quick reference books, but are nevertheless eminently practical in their outlook.

Synthesis differs from design as generally practised, i.e. mainly working backwards from results of particular cases of analysis. However, in synthesis solutions may not exist and, if they do, are not in general unique. In the author's own lucid words:

"The term network synthesis when correctly used does not apply to any and all procedures whereby a circuit is designed to meet stated requirements . . . by making a judicious guess . . . as to general configurations and (by) a continued cut-and-dry process. This sort of thing is not network synthesis, the essence of which resides in the fact that the structure of the network and all of its element values are produced by the process itself and that all questions . . . (of) . . . tolerance . . . (etc.) . . . are settled at the outset . . . (The) initial step, which is an important part of the entire process in referred to as . . . the approximation problem. Once its solution is accomplished . . . there is no more guessing involved. The synthesis procedure (then) yields a family of so-called equivalent networks, any of which exactly realizes the stated rational function."

With this point of view, and perhaps goaded by the knowledge that a future volume will be needed for advanced applications, Professor Guillemin quickly gets down to fundamentals. About three-quarters of the book is a carefully laid groundwork of the various known realization techniques. Only after establishing the theoretically possible, does he attack the approximation problem, in a single big chapter, and finally he discusses time domain synthesis in a long, concluding chapter.

Techniques of Magnetic Recording

Joel Tall. Brett-Macmillan Ltd., Toronto; 472 pp; $7.95.

Magnetic recording became a reality in 1898 when the Danish inventor Valdemar Poulsen took out patents for a workable magnetic recorder. Since then, this medium has come to play an important part in our lives particularly after the period of World War II. Joel Tall traces through the early developments of magnetic recording in the first chapter of his interesting book on the techniques.

A chapter on the theory of magnetic recording is followed by a discussion on drive mechanisms, erasing, recording sound in nature, editing, legal problems and other interesting facts on uses of this recording medium.

This is not a textbook. Rather, it is an interesting account of various phases of magnetic recording written in a style that is easy to follow and which should appeal to both the technical and nontechnical mind. Mathematics have been avoided but this does not detract from the value of the book as far as the "user of magnetic recording" is concerned. In fact, it undoubtedly contributes to the useful nature of the book as far as the average reader is concerned.

Electronics Express

International Physical Index, Inc., New York.

A series of scientific periodicals based on translations from sixty-seven current Russian technical periodicals and transactions will appear in three "Expresses." These cover electronics, automation and physics. Each express will contain forty pages per issue and will appear ten times per year. The contents of a single issue will consist of 2 to 4 complete articles, 10 to 20 excerpts in the author's words, 30 to 50 abstracts, and as many as 100 annotated titles. Price per year for each Express is $57.00.

Van Nostrand's Scientific Encyclopedia

D. Van Nostrand Co. (Canada) Ltd., Toronto; 1,800 pp.; $35.00.

This third edition contains more than 100,000 definitions, 14,000 articles and 1,400 illustrations from all the major branches of science, including nuclear science and engineering, guided missiles, electronics, radio and television.

Industrial Control Circuits

Sidney Platt. (John F. Rider, Publisher) Charles W. Pointon, Toronto; $4.10.

The author looks at industrial control through the eyes of a person with little or no knowledge of this field, explaining the circuits that govern the initiation, processing and finishing stages of industrial electronic equipment. Subjects include electronic relay control and timing circuits, photoelectric control, power control and industrial control instrumentation.

Plant Engineering Practice

The editors of Plant Engineering magazine. F. W. Dodge Corp., N.Y.; 704 pp; $18.50.

This is a practical book covering every major area of plant engineering activity. It contains 226 detailed studies on sites and layout, construction, housekeeping and safety, materials handling, maintenance, paints and protective coatings, mechanical power and piping systems, electric power, lighting, utilities, heating, ventilating and air conditioning, instrumentation and quality control, shopwork.

Vacuum Tube Rectifiers

Dr. Alexander Shure, editor. (John F. Rider, Publisher) Charles W. Pointon Ltd., Toronto; $1.60.

This is volume 21 of the Electronic Technology Series and covers physical characteristics of rectifiers, single phase rectifiers, polyphase rectifiers, output filter circuits and design data. Tables of tube characteristics are included.

(Continued on page 52)

Marine radiotelephone for small vessels meets D.O.T. Spec.

A new crystal controlled marine radiotelephone, SEAFARER Model CN-26 complies fully with Department of Transport specification No. 112 for noncompulsory fitted vessels and CSA requirements. Designed for convenience of installation, maintenance and operation, it is suitable for desk or bulkhead mounting and operates in the band of 1,600 to 6,000 kc. It also operates in the broadcast band of 540-1,600 kc. Full press-to-talk operation is provided and the receiver output can be switched to earphones for privacy and conversation.

Canadian Marconi Co., Marine Departments. (101)

Automatic wave analyzer range is 3 to 10,000 cps

Davies automatic wave analyzer provides frequency analysis from 3 to 10,000 cps of any repetitive complex wave form. It produces a permanent record, plotted as either amplitude vs frequency (Fourier) power vs frequency, or amplitude of a specific frequency vs time. Cross spectrol or transfer functional data is provided when two channels are used. Frequency accuracy is within 1 cps from 30 to 50 cps and 2% from 50 to 10,000 cps. amplitude accuracy is ± 5% of reading or ± 0-2% of full scale, whichever is larger.

First developed for aircraft studies, the analyzer can be used for scientific, environmental, acoustical, medical and general research laboratory use as well as for vibration, noise and shock analysis in vehicles, aircraft, missiles and ships.

Honeywell Controls Ltd., Toronto 10. (102)

Milli-microsecond time measuring system

For such applications as radar range calibration, shock tube studies, explosion studies, neutron time-of-flight measurements and propagation studies, the Eldorado model TMS-3100 milli-microsecond time measuring system — "Nanosec," has been developed. It covers the time spectrum from 0 to 3 microseconds with a total of 15 ranges. It can resolve an interval as short as 3×10^{-9} seconds.

The instrument requires that the interval of interest be represented by electrical pulses occurring at the beginning and end of the interval. A time interval is measured by converting the interval to a single pulse whose amplitude is linearly proportional to time. The amplitude of this pulse is then measured by a 20-channel amplitude analyzer.

By incorporating external delay elements it is possible to measure time elements as long as five microseconds with a resolution of 0.003 microseconds. Where desired, the amplitude analyzer may be operated separately as a conventional multi-channel pulse height analyzer.

Radionics Ltd., Montreal. (103)

Lightweight rf filter

A low-pass rf filter to meet the requirements of limited space and low weight has been designed for low insertion loss in the communication band of 225 to 400 mc with attenuation in the 950 to 1,200 mc band of 80 db. The filter weighs less than 5 oz. and measures 4¾ in. x ¾ in. x 1¼ in.

Bird Electronic Corporation, Cleveland, O. (104)

Large capacity diesel engine generating plants

Large capacity (85 to 380 kw) flywheel, no-brake generating plants utilizing medium speed range diesel engines have been developed to maintain a constant source of power to telecommunication systems, computers, radar sets, etc. The basic unit consists of a Blackstone medium speed engine with an air-operated clutch, nodal damper coupling, flywheel of 5 ft. 9 in. diameter and alternater with direct coupled exciter. The engine is provided with fully automatic remote control and protection and on resumption on main supply is automatically synchronized.

Canadian Lister Blackstone Ltd., Toronto. (105)

Standard bridge for high resistance measurements

Developed for making accurate resistance measurements in the nuclear and missile fields, Mid-Eastern Electronics Standard Bridge operates in the range of 1,000 ohms to 110 million megohms. Basic instrument accuracy is rated at 0.02% from 1000 to 11×10^6 megohms. Accuracy is 1% from 11×10^6 to 110 million megohms. The instrument is battery operated.

John R. Tilton Ltd. 106)

Mobile oscillograph recorder

Edin mobile 2-channel recording instrument depicts and records voltage, current, pressure, vibration, temperature, displacement, strains, acceleration or force. It contains a 2-channel direct writing recorder with a choice of any two standard amplifiers. The sensitive unit will reliably record for example, strains as low as 10 micro inches per inch and currents as low as 1 micro volt. It weighs 100 lb and is mounted on rubber tired wheels.

A. C. Wickman Ltd., Toronto. (107)

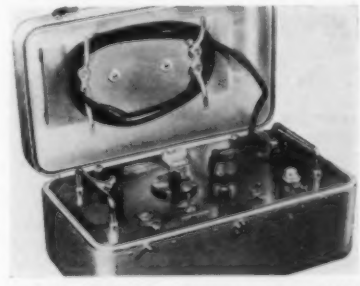
Automatic soldering machine for printed circuits

The Flowsolder machine creates a solder wave of controlled height over which printed circuit boards can be moved without creating any break in the production line. Molten solder from the reservoir is pumped through a short duct terminating in a nozzle. By varying the pumping rate the height of the solder wave at the nozzle can be controlled. The impeller blade, duct and nozzle are contained in the reservoir to prevent trapping flux or air to ensure clean solder free from oxide or dross, without the constant necessity of skimming.

Electrovert Ltd., Montreal. (108)

High-speed weighing unit

A portable weighing unit Model 9000 contains a controlled circuit having a response of 0.01 sec. This feature plus the 0.1% accuracy makes it suitable for laboratory use in load or thrust measurements as well as for use on batch control, bagging machines, loading or fueling operations.



Capacity is from a few grams to 250 tons and it can be used on ac or dc power supplies.

Hoover Co. Ltd., Hamilton, Ont. (109)

(Continued on page 44)

Electronic pump achieves clean vacuum below 10^{-9} mm mercury

Clean vacuums in excess of 10^{-9} mm of mercury are claimed possible with the VacIon vacuum pump. This operates in a closed system, utilizing electronic principals to ionize and remove gas molecules without the need for refrigeration systems, cold traps and vapor traps. A pumping speed of ten litres of gas per second at 10^{-7} mm Hg can be achieved.

The VacIon also measures its own vacuum. The current flow is reduced automatically as gas is removed and ionization declines. A microammeter furnishes a constant reading of the pump current, which is a measure of the degree of vacuum achieved. A mechanical pump reduces initial pressure to between 15 to 20 microns, at which point the VacIon begins to function.

Varian Associates of Canada Ltd., Georgetown, Ont. (110)

Miniature high speed counter tube

A miniature version of the 100 kc cold cathode decade counter tube has been developed by Sylvania. Designated Type 7155, the tube is equipped with three output cathodes in a T-5½ bulb. It may be used for both visual and electrical readout in portable or other miniature equipment.

The tube operates on the principle of transferring a glow to successive cathods pins which surround a disc-shaped anode. Each pulse from a sensing device causes the glow to advance to the next cathode pin.

Hackbusch Electronics Ltd., Toronto. (111)

Universal a-c voltage regulator

Sorensen a-c voltage regulator model APR1010 can be used to regulate rms, average and peak voltages, independent of wave form. Turning a switch will match the output to special requirements of a particular load. Five different sensing arrangements are available: internal (normal a-c regulation), extenal a-c (any a-c voltage), remote (115 vac at a remote location) constant current, and d-c. Electrical specifications include the following. Input voltage: 95-140 vac at 60 cps ±10%; input current: 13 amp with 1 kva load; output voltage: 110-120 vac rms; load range: 0-1,000 va; regulation accuracy: ±0.1% with either line or load changes, for any selected regulating function.

Bayly Engineering Ltd., Ajax, Ontario. (112)

Shielded mount for 2K25 klystron

A completely enclosed and shielded tube mount (Narda model 980B) for the 2 K25/723 AB klystron in 1 x ½ wave guide provides correct impedance match for maximum power output. The mount permits the klystron shell to be operated at potentials above ground without danger of shock. Internal wiring is accessible and leads are brought through a dissipative plastic that will not chip or shatter due to mechanical shock.

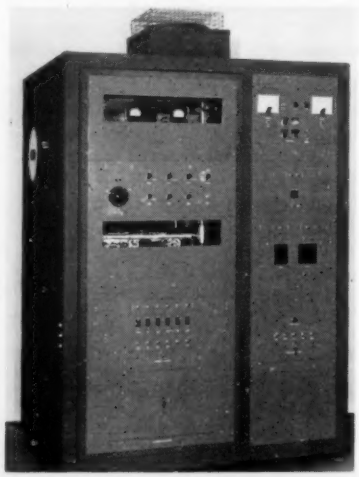
An unshielded mount (Narda model 980A) is also available, consisting of an octal socket on a section of waveguide. The shell is grounded since the klystron is exposed and a three-foot cable with tinned leads is fixed to the mount.

MEL Sales Ltd., Arnprior, Ont. (113)

High voltage hard-tube pulse modulator

The Levinthal Model 70M hard-tube, high-voltage pulse modulator is a flexible tool for experimental tube testing. It is capable of two distinctly different modes of operation: cathode pulsing and modulating-anode pulsing. In both modes, it operates anywhere in the range from 30 cps to 12,000 cps and with pulse lengths continuously variable from 0.5 to 30 microseconds.

As a cathode pulser it will pulse from 0 to 35 kv up to 10 amp. As a modulating-anode pulser, it will pulse from 0 to 35 kv into a 25 $\mu\mu$f load.

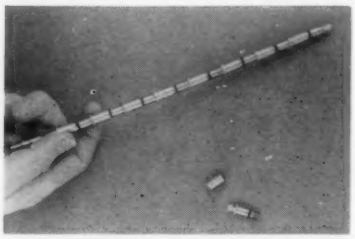


Equipment consists of one cabinet containing a 35-kv 0.1-amp power supply with less than 0.1% peak-to-peak ripple, a 0- to 20-volt, 0- to 20-amp filament supply for the tube under test and a special pulse-modulator unit capable of being switched to two modes of operation.

Levinthal Electronic Products, Inc., Palo Alto, Calif. (114)

Expendable silicon rectifier

This silicon rectifier can be used singly or assembled into series chains for higher voltage applications. The individual unit is sealed and threaded at each end so that it can be screwed into bushings, or into a chassis heat sink or plugged into a clip holder. Each unit is 1 in. long with an inverse voltage rating of 400 volts and maximum forward current of 750 ma. To produce a high voltage rectifier



a number of the units are connected end-to-end with the bushings to form a series chain. Threaded units with current ratings up to 5 amp may also be had for similar assembly.

Audio Devices Inc., Santa Ana, Calif. (115)

Epoxy glass base laminate for high temperatures

Epoxy bonded fibre glass laminate, Phenolite Grade G-11-861, retains 70% to 80% of its original flexural strength when tested at 150 C after conditioning for one hour at that temperature. It is also made as copper clad Phenolite Grade G-11-861-1 for printed circuit applications. Bond strength is 10-15 lb; dip solder resistance is greater than 30 sec. at 500 F. G-11-861 meets military requirements for Type GEE MIL-P-18177-A, and will meet the proposed requirements for the new type GEB.

National Vulcanized Fiber Co., Wilmington, Delaware. (116)

Moving coil vibration pickup

Dynavolt vibration pickup is a moving coil device to convert motion into voltage. Resonant frequencies from 7 to 80 cps permit its use as a displacement, velocity or acceleration transducer. Outputs as high as 1.0 volt/inch/second may be had under critically damp operation. Coil resistances may be specified from 125 to 1000 ohms. The unit is permanently sealed and normally supplied with ½ in. x 20 thread stud for mounting; however, other base fixtures may be ordered.

Mandrel Industrial Instruments, Houston, Texas. (117)

(Continued on page 46)

Reports — continued

DDP contracts, cont.

equipment, $20,354; Canadian Marconi Co., Montreal, transmitter and associated equipment, $114,044, also electronic equipment, $19,665; Canadian Westinghouse Co. Ltd., Ottawa, redesign and modification of electronic display unit, $15,000; Railway & Power Engrg. Corp Ltd., Montreal, electronic equipment, $19,226.

Representatives add new lines

The B. F. Goodrich Co. Sponge Products Division, Shelton, Conn., is represented in Canada by E. G. Lomas, Ottawa (microwave absorbing materials).

Computing Devices of Canada Ltd., Ottawa and Toronto, are handling Canadian sales of the transistors and tubes made by the Red Bank Division of The Bendix Aviation Corp.

Mid - Eastern Electronics Inc., Springfield, N.J., are now represented by John R. Tilton Ltd., Toronto (ultra-high resistance bridges, intervalometers, etc.).

Dayrand Ltd., Montreal, formed in 1957, has been appointed Quebec representative for C. R. Snelgrove Co. Ltd., Toronto (quartz crystals, frequency standards and crystal ovens); also as Canadian representative for Dielectric Products Engineering Co. Inc., Raymond, Me. (transmission line, antennas, diplexers, dehydrators).

F-R Machine Works, Woodside, N.Y., have named Radionics Ltd., Montreal, as Canadian representative for their microwave test equipment.

Radio and television receiver sales

RETMA of Canada figures show both radio and television receiver sales in February down on 1957. Total radio sales were 31,284 units (Feb. 1957 — 38,958); television, 33,333 units (39,336).

News in brief

Electronic Controls Ltd., formerly of Toronto, has relocated in the Lanning Building, Belleville, Ont.

Atlas Radio Corp. Ltd., Toronto, representatives for the Kay Lab industrial television line of Kin Tel, San Diego, Calif., have recently made several demonstrations.

Closed circuit television has also been used recently by The Telegram, a Toronto newspaper, to show election results and wire photos to passers-by (Philips Electronics Industries Ltd.).

MUIRHEAD

TACHOMETER GENERATORS AND SERVOMOTORS

EXACTLY to BuOrd Spec

Mark 1 Mod 1 TACHOMETER GENERATOR *(Size 15)*

MUIRHEAD

Supply	115V 400c/s
Generated Voltage per 1000 rev/min	3·1V
Phase Shift at 3000 rev/min	5° lagging
Residual Voltage at 0 rev/min	
R.M.S. 0·013V : Fundamental	0·008V
Weight 7oz	200g

Mark 12 Mod 0 SERVOMOTOR *(Motor Tachometer Size 15)*

MUIRHEAD

Supply to Phase 1 115V 400c/s
to Phase 2 115V 400c/s or 57·5V 400c/s

MOTOR PERFORMANCE

Torque at Stall (minimum)	1·45oz in	104g cm
Torque at 2500 rev/min (maximum power output)	0·8oz in	58g cm
No Load Speed (minimum)		4500 rev/min
Weight with Generator	14oz	400g

The Generator figures are the same as for Mark 1 Mod 1 above

Mark 16 Mod 0 SERVOMOTOR *(Motor Tachometer Size 18/15)*

MUIRHEAD

Supply to Phase 1 115V 400c/s
to Phase 2 115V 400c/s or 57·5V 400c/s

MOTOR PERFORMANCE

Torque at Stall (minimum)	2·35oz in	170g cm
Torque at 2500 rev/min (maximum power output)	1·5oz in	110g cm
No load speed (minimum)		4500 rev/min
Weight with Generator	19oz	540g

The Generator figures are the same as for Mark 1 Mod 1 above

Servomotors can also be supplied with various low impedance control windings. Write stating your requirements.

Data sheets giving full information on the above and a handy reference sheet on our full range of Synchros and Servomotors are available on request.

MUIRHEAD INSTRUMENTS LIMITED

STRATFORD · ONTARIO · CANADA Telephone: 3717 & 3718

333/3C

Circle No. 23 on Reader Service Card

High-low temperature test chamber added to CARL services

A new Conrad high-low temperature chamber has been added to the facilities at Canadian Research Test Laboratory. Temperatures in excess of —100F to 300F are possible. The chamber measures 3 ft wide, 3 ft deep, 8 ft long and can be filled with brine, ethylene glycol or alcohol for immersion tests. Sealed ports in the sides allow the insertion of drive mechanisms and operating cables so that the equipment can be operated while being tested.

The laboratory services are available on a rental basis.

Canadian Applied Research Ltd., Toronto. (118)

For direct measurement of

F. M. DEVIATION from 4 to 540 Mc/s

MEASURED TO WITHIN 3%

Marconi Carrier Deviation Meter TF 791C

The Marconi direct-reading Carrier Deviation Meter, TF 791C, is designed for use with all types of systems from narrow-band mobile communications to hi-fidelity broadcasting. High measurement accuracy is assured by a built-in crystal-controlled deviation standard. The Meter covers the carrier frequency range of 4 to 540 Mc/s, has a modulation frequency range extending from 50 c/s to 35 kc/s, and deviation is measured on any one of the four direct reading ranges of 5, 25, 75 and 125 kc/s full-scale. There is an independently-buffered l.f. output for aural or visual monitoring of the demodulated signal.

Carrier Frequency range: 4 to 540 Mc/s in 7 bands.

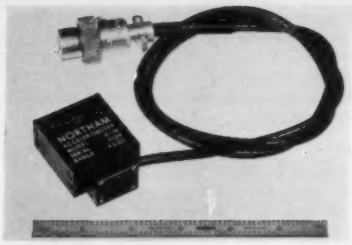
Frequency Deviation Range: 0 to ± 5 kc/s, 0 to ± 25 kc/s, 0 to ± 75 kc/s and 0 to ± 125 kc/s.

Frequency Deviation Accuracy: For modulation frequencies between 50 c/s and 25 kc/s, ± 3% of full scale. For modulation frequencies between 25 and 35 Kc/s, ± 3% of full scale ± 3% of the reading.

For further details, write to: **CANADIAN MARCONI COMPANY,** *Instrument Dept.,* 6035 Cote de Liesse Road, Montreal, Que.

Marconi CMC CANADIAN MARCONI COMPANY **CANADA'S LARGEST ELECTRONIC SPECIALISTS**

Circle No. 18 on Reader Service Card



Ballistocardiography accelerometer

Ballistocardiography measures heart action by measuring the displacement of the human body as it reacts to the pumping action of the heart. A new approach is to place the patient on a bed which is as light as possible and suspended so that transducers can pick up high frequency detail in the displacement caused by heart action.

Northam A-14 accelerometer has a flat response from O-40 cps, and its range provides adequate coverage for the study of heart action. Model A-14 is of the variable reluctance type. The seismic element is situated between two balanced E-core coil structures, which are fixed in the case halves with epoxy. Air damping provides long term stability in performance and relative immunity to changes in ambient temperature.

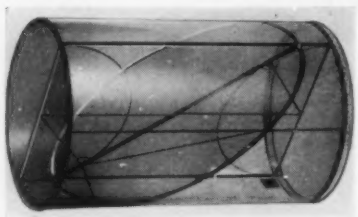
Model A-14 is designed to operate with 3-volt rms excitation at 3,000 cps, giving a nominal output of 50 mv/v. It is sensitive enough to have a full scale of ± 0.5g and may be used with direct writing recorders.

Northam Electronics Inc., Altadena, Calif. (119)

Clear plastic models aid science teaching

To help visualize plane geometry, solid geometry, descriptive geometry, mechanical drawing and analytical mechanics, clear plastic models are available. They can be obtained in many configurations, either singly or in integrated sets.

Physics Research Laboratories Inc., Hempstead, N.Y. (120)



High current diffused silicon rectifiers

For power supply applications up to 400 amperes at 350 volts peak inverse, or up to 5,000 amperes in stacked combinations, these silicon rectifiers are rated up to 99% efficiency depending on application. They will operate from —65 C to 150 C without derating and will have a forward drop of less than 1 volt per cell.

Taylor-Leslie Mining & Engineering Corp. Ltd., Toronto. (121)

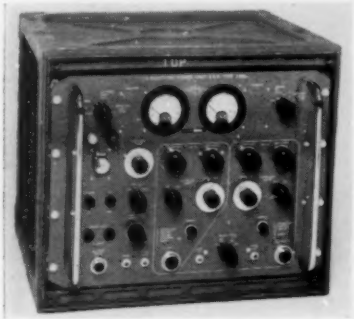
(Continued on page 47)

Power unit for klystrons

Airmec klystron power unit type 1856 has been designed to operate low voltage klystron oscillators with a high degree of frequency and power stability. It will operate klystrons either singly or in pairs (as signal source and local oscillator). Separate controls are provided to facilitate the operation of two tubes simultaneously and completely independently of each other.

It may be used as a general purpose stabilized power supply having low output impedance with internal oscillators providing sawtooth and square wave modulation. External pulse modulation may be applied. The power unit produces a fixed negative going synchronization pulse and a time base voltage variable in amplitude for external use.

Radio Communications Equipment & Engineering Ltd., Montreal. (122)



Portable 110-deg picture tube tests TV sets

Picture tube type 8YP4 has been designed for testing TV sets. It is a 110-deg tube, 8 in. in size, with a 6.3 volt, 600 ma heater. It may be substituted for regular tubes operating on 6.3 volt - 600 ma; 6.3 volt - 450 ma; or 8.4 volt -450 ma.

Sylvania Electric (Canada) Ltd., Montreal. (123)

Protects telephone lines from high voltage

If open wire telephone lines are accidentally touched by high voltage power lines carrying less than 3 kv, conventional station protectors are usually sufficient to protect the telephone lines. Beyond this, auxiliary protectors are required. The use of circuit reclosers and fuses in power circuits have made it necessary to design new telephone protectors with better time-current characteristics. Number 118A protector is rated at 2,000 volts, has higher current carrying capabilities than the commonly used line wires, and has a time current characteristic better than that of the No. 99A protector.

Northern Electric Co. Ltd., Montreal. (124)

(Continued on page 48)

to lap the servo field
Fast getaway wins at 200°C
Beckman Rotating Components shade the field in the first heat . . . or any heat up to 200°C . . . by accelerating, braking and reversing, instantly and precisely. Stall them, even at full wattage input. Then step on the gas. They'll rev up to full power immediately. Stock models are: Servomotor and Servomotor-Rate Generator . . . available in sizes 8, 11, 15 and 18. Inertia-Damped Servomotor and Velocity-Damped Servomotor . . . in sizes 8, 11 and 15.
Beckman Inertia-Damped Servomotors are modified to produce the mechanical equivalent of an AC notching filter network. Consistently cool performers, they are inherently stable and insensitive to carrier frequency variations, thereby stabilizing the servo system.
For all the facts about Beckman Rotating Components, cut down for quick reading, write for data file 53F.
Beckman® Helipot
Helipot Corporation
Newport Beach, California
a division of
Beckman Instruments, Inc.
Engineering representatives
in principal cities
1250
Circle No. 20 on Reader Service Card

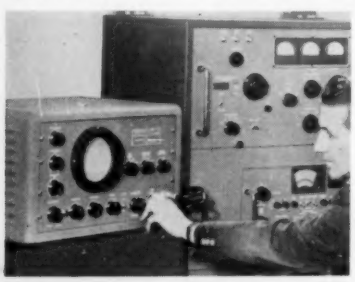
Machine can automatically sort 3,000 diodes per hour

Astramatic Model 276 diode handler is capable of sorting up to 3,000 diodes per hour into as many as 16 classifications. The sorting machine adapts to new or existing testing equipment and readily accommodates a four perimeter forward-back resistance test sequence without rehandling. Diodes are transported automatically from hopper to bins and bin contents are displayed on counters. The machine has been designed for use by diode manufacturers and large scale diode purchasers.

Stromberg-Carlson, Rochester, N.Y. (125)

Analyzer designed for ssb investigations

Panalyzor Model SB-12a, Type T-100 has been designed specifically for ssb investigations. Operation is simplified with preset narrow band scans of 150, 500, 2,000 and 10,000 cps and a new 20 db range-extending attenuator to speed the standard two-tone test; hum side band determinations and other spectrum measurements. In-band (odd order) intermodulation products are suppressed at least 60 db. The instrument has improved I-F skirt selectivity and a high order to sweep stability (AFC on scans up to 2 kc).



The input centre frequency is 500 kc. Maximum deviation is ±50 kc. Resolution varies from 3 kc at a rapid rate of scan down to less than 10 cps. The rate of scan may be varied from 0.1 to 30 cps. Direct sensitivity is 20 microvolts full scale line and conversion sensitivity is 2 millivolts.

Panoramic Radio Products, Mount Vernon, N.Y. (126)

Cooling fans for use in missiles and aircraft

Two new Rotron cooling fans are available for use with electronic gear in missiles and aircraft. Aximax-3 will deliver 165 cfm free delivery when turning at 20,000 rpm. The fan is 2.8 in. in diameter, 2.3 in. in depth and weighs 14 oz.

Propimax-2 will deliver 120 cfm free air when turning at 20,000 rpm. It measures 3-in. in diameter by 1.4 in. in depth and weighs 6 oz.

Both fans are obtainable with a choice of constant speed motors or from variable speed Altivar designs which maintain constant cooling efficiency at changing altitude. They are available for operation on 115 volt a-c single phase, or 220 volt a-c three phase, 400 cps power supplies. Air flow is reversible.

Hoover Co. Ltd., Hamilton. (127)

Transistor and diode radiators

Heat dissipation in transistors and diodes is assisted by two new radiators. Heat radiator 3 AL-635 is designed for press fit over the JETEC-30 transistor case. It will maintain a dissipation coefficient Kr 0.28 C per milliwatt.

To prevent thermal run away in power transistors radiator number 3 B640 has been designed to reduce operating temperature of diodes as much as 30 C under typical conditions. It consists of a series of black ebanol-finished metallic rings or fins mounted on a plate which is interposed between the diode and the mica insulating washer on top of the chassis.

The Birtcher Corporation, Los Angeles. (128)

Building alarm system uses radar

Electro-Security Corp. Radar-Eye alarm system uses high frequency radiation to detect any movement within the area surveyed by the equipment. It is used primarily for protecting warehouses, offices and other buildings against unauthorized intrusion. The equipment operates from 115 v 60 cps and draws less than 60 watts.

W. R. Watkins Co. Ltd., Toronto (Ontario only), Lund Aviation, (Canada) Ltd. (remainder of Canada) (129)

Measuring oscilloscope accuracy better than 2%

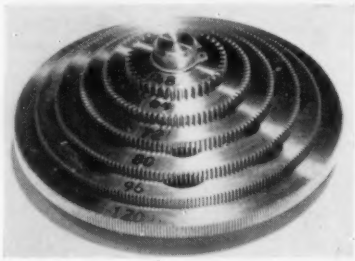
Developed as a measuring instrument, as well as a display unit, Solarscope type CD.643 is claimed to have an accuracy better than 2%. Measurements can be made without the use of batteries or other measuring gear.

"Y" deflection: constant bandwidth, dc to 15 mc; maximum sensitivity 100 millivolts per cm.

Time base: sweep speed 10 cm per microsecond to 10 cm per second; smooth expansion up to x100; maximum sweep speed limited by "X" amplifier.

Amplitude measurement: calibrated shift system. Time measurement: calibration pips.

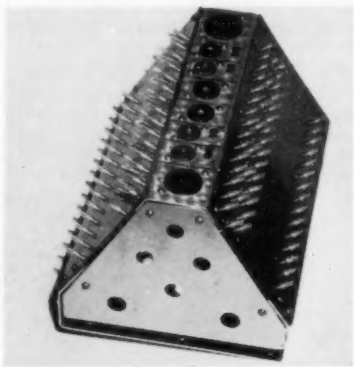
Computing Devices of Canada Ltd., Ottawa. (130)



Fine-pitch spur gear checking gauge

A new gauge is available for checking the pitch and pressure angle of fine-pitch spur gears. This unit is made with 48, 64, 72, 80, 96 and 120 pitch master checking gears. The material is stainless steel and is clear passivated.

PIC Design Corporation, East Rockaway, N.Y. (131)



Breadboard stand speeds prototype work

An "A" shaped breadboard has been developed to speed prototype work while conserving bench space and adding to the convenience of working on the circuit. It is available in two standard sizes, 4½ in. and 8½ in. long. Two or more may be bolted together to make longer units. There is a choice of eyelets in the side panels and the tube socket panels are removable to get any combination desired.

Allied Circuit Techniques Ltd., Oakville, Ont. (132)

(Continued on page 51)

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- Circle the key number on one of these cards
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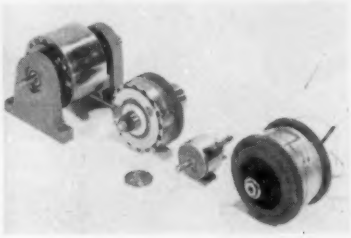
Magnetic clutch

Magtrol magnetic clutches, brakes, clutch-brake combinations, and zero backlash proportional servo-torque controllers are now being manufactured in Canada by Found Bros. Aviation Ltd. The units illustrated, l-r, produce 32, 16, 10 and 12 in. ozs. of torque, independent of speed, for control of power of the order of 3 to 5 watts at a maximum of 40 to 50 ma.

Canavia Engineering & Sales Ltd., Malton, Ont. (133)



Portable constant bandwidth oscilloscope

The light weight (44 lb) of Solarscope CD.814 permits it to be used readily in schools, production lines, service shops and in the field. Characteristics include the following: constant bandwidth: —3 db from 10 cps to 8 mc; maximum sensitivity: 30 mv per cm approximately; amplitude measurement: by square wave calibrating wave form with undistorted picture by both amplifiers of 4 cm at 10 mc; time base: repetition rate from 17.5 cps to 200 kc approximately; sweep speed: maximum of 0.5 cm per microsecond without expansion.

Computing Devices of Canada Ltd., Ottawa. (134)

Battery operated inverter

Operating from an input voltage of 12, 24 or 48 volts d-c Mandrel Industries Model PV-2 inverter will provide an output of 115 volts (adjustable), 50, 60 or 400 cps. It is a tuning fork controlled inverter, transistorized throughout to drive synchronous motors rated up to 140 volt-amp input. The output is a modified square wave stable to 0.01%.

Radionics Ltd., Montreal. (135)

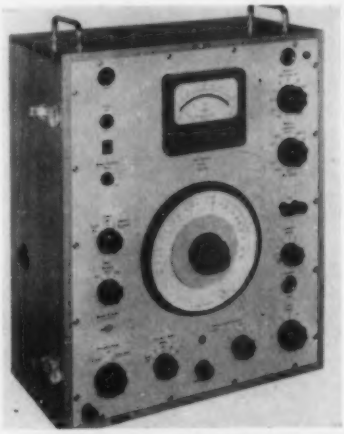
Audio signal generator and control system

Working on the heterodyne principle Brush audio signal generator and control system model BL-1015 features a frequency range from 2,000 to 4,000 cps. The main frequency scale is completely logarithmic and has an illuminated dial. An accuracy better than 2% is provided by a built-in vacuum tube voltmeter. Other features include: accurate reading at low frequencies; automatic output attenuator in 10 db steps; and automatic frequency scanning.

The facilities for scanning consist of a worm gear drive coupled through a magnetic clutch to the main tuning condenser. Normal operation employs a flexible drive shaft connection to the chart motor of the model BL-2304 level recorder, but other drive sources may also be used.

The instrument can be used for exciting and controlling shaker tables where the oscillator is used as a signal source and compensation can be made for nonlinearities by an increase or decrease in the output voltage of the oscillator.

Brush Instruments, Cleveland, Ohio. (136)



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Library—continued

Catalogues and brochures from the manufacturers

Vinyl wire markers for permanent wire identification in oily and solvent-laden atmospheres are listed in 8-page catalogue. W. H. Brady Co., Milwaukee, Wis. (137)

Infrared spectrophotometers for routine laboratory analyses are described in bulletin No. 724. Bechman Scientific Instruments Div., Fullerton, Calif. (138)

Waveguide components and test equipment, more than 300 different types, are described in the 48 page Microwave Associates catalogue 58 CP. E. G. Lomas Co., Ottawa. (139)

Fasteners — detailed specifications, engineering drawings, applications and installation information in 40-page catalogue. Simmons Fastener Corp., Albany, N.Y. (140)

Electro - mechanical components: specialized valves, solenoids and switches. Twenty-three page catalogue. Koontz-Wagner Electric Co., Inc., South Bend, Ind. (141)

Philips' Technical Library. List of books and periodicals published by the Philips Technical Library. Philips Electronic Industries Ltd., Toronto (142)

Military Variable Resistors, composition and wire wound, are listed on two stock sheets number 163 and 164. C. C. Meredith & Co. Ltd., Streetsville, Ont. (143)

Index to Computer Literature lists publications prepared by Ferranti Ltd. and indicates charge, if any. Ferranti Electric Ltd., Toronto. (144)

Slide Rule Calculator selects electrical connector. DeJur Amsco Corp., Long Island City, N.Y. (145)

Electronics Buying Guide 1958. 232-page catalogue. Canadian Electrical Supply Co. Ltd. (146)

Microwave Tube Catalogue for 1958, 36 pages. Varian Associates of Canada Ltd., Georgetown, Ont. (147)

Microwave Test Equipment and Accessories described in 80-page Waveline Inc. catalogue. Beechey Enterprises, Toronto. (148)

Precision Instrument Components and new products for 1958 described in catalogues 14 and 15 by PIC Design Corporation. Tecneek Associates, Montreal. (149)

Turret terminals, terminal boards and electronic hardware listed in 40-page catalogue. Precision Metal Products Co., Stoneham, Mass. (150)

Standard Transductors, their characteristics and uses are described in 16-page catalogue. Control Division of Magnetics Inc., Butler, Pa. (151)

Relays, solenoids and switching coils. 36-page engineering catalogue No. 58 provides specifications and design information on Comar Electric Co. products. Musimart of Canada Ltd., Montreal. (152)

Current limiting circuit breakers are described in 19-page application data bulletin No. 5043-A. I-T-E Circuit Breaker Co., Philadelphia, Pa. (153)

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Low-cost, streamlined clips
with **SNAP!**

which is taking 1/2500th second to snap shut upon a wafer. Talk about acceleration!—the upper jaw hits 60 MPH in three-eighths of an inch. The upper jaw and flying wafer fragments have been caught in many images along their paths of movement.

Photographed by means of a special process, it graphically illustrates the "snap" in Mueller's traditionally snappy springs. These springs provide a mean, corrosion-cutting bite for perfect test connections.

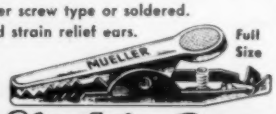
THE NEW "70 SERIES" ALLIGATORS FEATURE:

Simple, direct, streamlined design, and lower cost than the famous "60 Series".

Faster, easier connection, whether screw type or soldered.

A new patented hinge, and cord strain relief ears.

WRITE FACTORY TODAY FOR FREE SAMPLE PACKET SHOWN ABOVE



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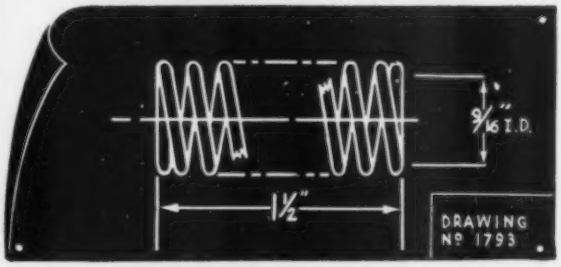

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Canadian astronautical society studies space travel

Canada's interest in missiles and space travel has received a much needed stimulant. Members of the de Havilland Aircraft of Canada, Guided Missile Division, provided the nucleus for The Canadian Astronautical Society which is gathering membership among the people interested in this work. Their objectives include a program to investigate and promote the advancement of all branches of scientific study comprising the field of astronautics, and to co-ordinate and conduct experimental and theoretical research. Five specialist groups have been established — propulsion, electronics, analysis, astronomic and recovery.

At their April meeting a talk concerning the re-entry of high speed bodies into the upper atmosphere was given by Professor N. G. Patterson of the Institute of Aerophysics, University of Toronto. A short documentary film of the society's recent static firing was also shown.

The society is essentially a professional group, but provision has been made to admit non-professionals into the membership. A student section is being formed to promote scientific interest among young persons and give them proper guidance and advice.

Because of the close link with the electronics industry, The Canadian Astronautical Society has been asked to present a complete session of technical papers at the IRE Canadian convention.

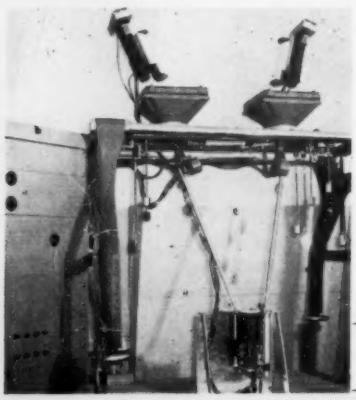
Information may be obtained from A. E. Maine, the de Havilland Aircraft of Canada, Downsview, Ontario.

A. B. Barnes of C.A.S. adjusts rocket motor for test firing in an electronically instrumented thrust measuring stand Proper safety precautions must be taken in this work

Electronic scanner speeds aero mapping

G. L. Hobrough and his associates at Photographic Survey Corporation, Toronto, have achieved a major breakthrough in the science of aerial mapping. Their automatic scanning correlator (Auscor) combines electronics and electro-mechanisms to scan stereo pairs and plot relative heights of image detail in aerial mapping. First models have been adapted to a Kelsh plotter stereo machine and results have been comparable with skilled human operators except that Auscor is faster and is free of the fatigue factor.

Photographic Survey Corporation is currently looking for a company to manufacture Auscor.



Electronic scanner on stereo plotter "reads" information on aerial photos

COMING EVENTS FOR YOUR DIARY

May

6-9	AIEE - IRE - ACM Western Joint Computer Conference. Los Angeles, Calif.
12-14	National Aeronautical & Navigational Electronics Conference. Dayton, Ohio.
19-21	Electronic Parts Distributors Show. Chicago.
19-23	International Convention on Microwave Valves. I.E.E., London W.C.2.
21-23	Engineering Institute of Canada annual meeting. Quebec.

June

2-4	AIEE-ISA-IAS-ARS National Telemetering Conference. Baltimore, Md.
9-10	Canadian Conference for Computing and Data Processing. University of Toronto.
9-11	Canadian National Business Show, Exhibition Park. Toronto.
16-18	Second National Convention on Military Electronics. Washington, D.C.
22-27	AIEE Summer General Meeting. Buffalo, N.Y.

August

5-8	AIEE-IRE Nonlinear Magnetics and Magnetic Amplifiers Conference. Los Angeles, Calif.
19-22	Western Electronic Show and Convention. Los Angeles, Calif.

TWO DOWN

Sputnik 2 entered the denser layers of the atmosphere in the morning hours of April 14 and disintegrated. Parts of it were scattered along a route proceeding in a southeasterly direction over the Lesser Antilles, Brazil, and the Atlantic Ocean. In five months it had made nearly 2,370 revolutions around the earth, traveling some 62 million miles.

Directory for Canadian buyers

Finding the right component is often difficult, but trying to find the company that supplies it can be downright frustrating. If you don't believe it just ask the components engineers and purchasing agents . . . we did, and took their advice in setting up the CEE Components and Equipment Directory. This will be included in the June issue.

Now! Four new all-electronic sweep oscillators simplify measurements 3.95 to 18.0 KMC!

-*hp*- 684 Series Sweep Oscillators

Now -*hp*- offers 4 new electronic sweep oscillators covering the G, J, X and P bands, respectively.

These new 684 series instruments all have a wide range of sweep speeds so measurements of reflection, attenuation, gain, etc., can be displayed on an oscilloscope or recorded on X-Y or strip-chart recorders. Either CW or swept rf output is available.

The 684 series oscillators use new backward wave oscillator tubes whose frequency is shifted by varying an applied potential. Troublesome mechanical stops or tuning plungers are eliminated. Sweep range is continuously adjustable and independently variable; sweep rate is selected separately; either can be changed without affecting operation. Full band width can be covered in time segments from 140 seconds to 0.014 seconds.

Swept rf output is linear with time, and a linear sawtooth is provided concurrent with each rf sweep to drive an oscilloscope or recorder. Sweeps may be triggered electrically externally, or manually.

HEWLETT-PACKARD COMPANY

Represented in Canada by
ATLAS INSTRUMENT CORPORATION, LTD.
50 Wingold Avenue, Toronto 10, Ontario
106-525 Seymour St., Vancouver 2, B.C.
72 Princess St., Winnipeg, Manitoba

4647

Cover full band, or any part

Use with 'scope or recorder

Direct reading, independently adjustable sweep range and rate controls

TYPICAL SPECIFICATIONS

Below are specifications for -*hp*- 686A Sweep Oscillator, 8.2 to 12.4 KMC. Specifications for -*hp*- 684A (G band), 685A (J band), and 687A (P band) are similar except for frequency range.

Types of Outputs: Swept Frequency, CW, FM, AM.

Single Frequency Operation

Frequency: Continuously adjustable 8.2 to 12.4 KMC.

Power Output: At least 10 milliwatts into matched waveguide load. Continuously adjustable to zero.

Swept Frequency Operation

Sweep: Recurrent; externally triggered; also manually triggered single sweep. Rf sweep linear with time.

Power Output: At least 10 MW into matched waveguide load. Output variations less than 3 db over any 250 MC range; less than 6 db over entire 8.2-12.4 KMC range.

Sweep Range: Adjustable in 7 steps 4.4 MC to 4.4 KMC.

Sweep Rate-of-Change: Decade steps from 32 MC/sec. to 320 KMC/sec.

Sweep Time: Determined by sweep range and rate; from 0.014 to 140 seconds over full-band.

Sweep Output: +20 to +30-volt-peak sawtooth provided at a front-panel connector concurrent with each rf sweep.

Modulation

Internal Amplitude: Square wave modulation continuously adjustable from 400 to 1200 cps; peak rf output power equals cw level.

External Amplitude: Direct coupled to 300 KC; 20 volt swing reduces rf output level from rated cw output to zero.

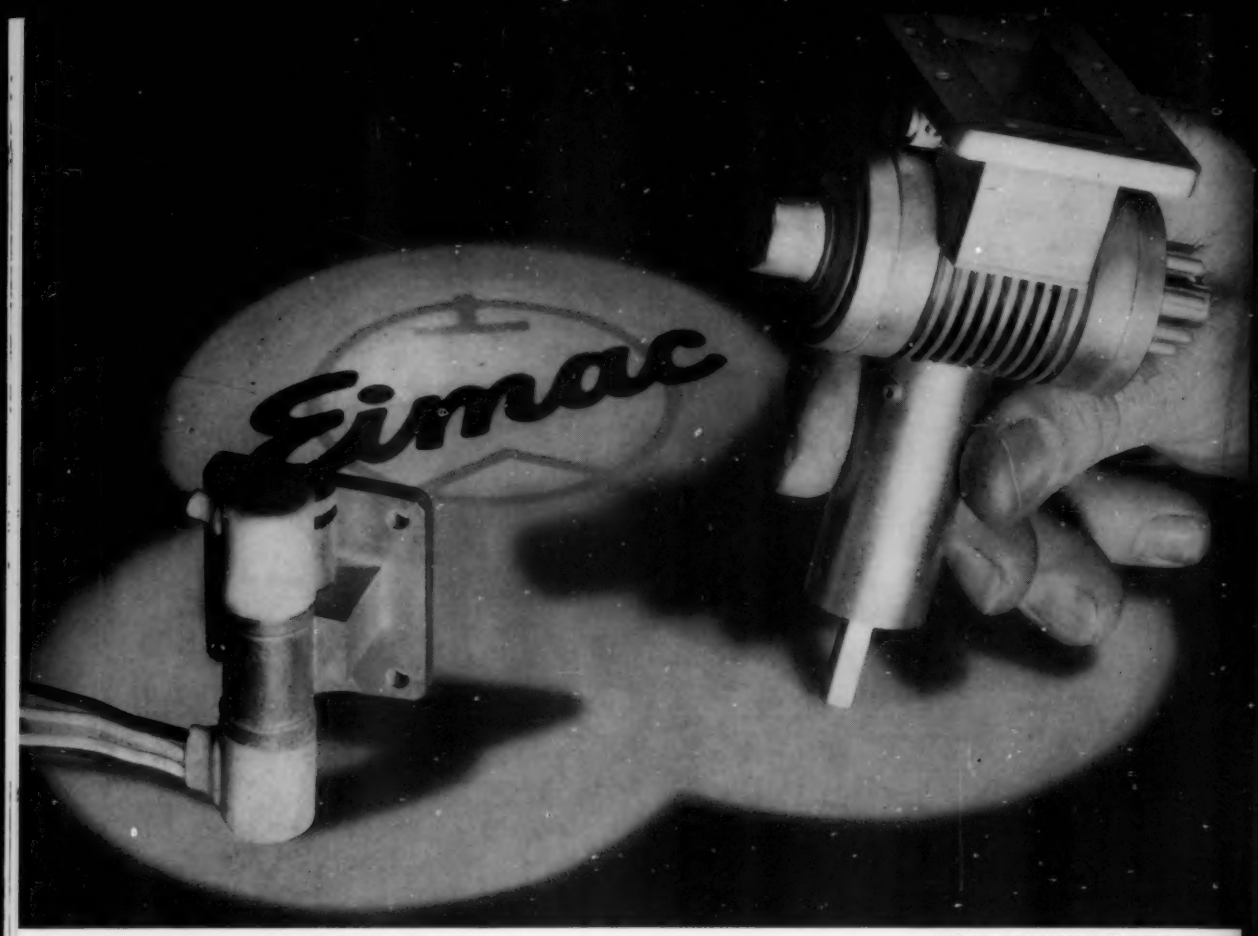
External Pulse: +10 volts or more, 5 millisecond maximum duration.

External Frequency: FM and external sweep voltages.

Price: -*hp*- 684A (3.95-5.85 KMC) $2,265.00
-*hp*- 685A (5.30-8.20 KMC) $2,265.00
-*hp*- 686A (8.20-12.40 KMC) $2,615.00
-*hp*- 687A (12.40-18.00 KMC) $3,115.00
(Prices above are f.o.b. factory for cabinet models. Rack mount instruments $15.00 less.)

Data subject to change without notice.

instruments save measuring time



1K20 Series X and K Band Klystron (left)
1K125CA C Band Klystron (right)

Eimac Announces...

Five New Ceramic Reflex Klystrons

Two important frequency ranges in the C, X and K bands are now covered by Eimac reflex klystrons. Eimac's advanced stacked ceramic design gives these tubes exceptional ruggedness and frequency stability.

The four new tubes of the 1K20 series cover 8500 to 11,700 Mc., at power levels up to 50 milliwatts. They are specifically designed for use in the severe environment of air-borne and missile radar systems. They will withstand vibration levels of 15G in any reference plane, with less than 100 kilocycle frequency deviation. Low beam voltage requirement and simple radiation cooling minimize the weight and complexity of associated equipment.

A new C-band tube, the 1K125CA covers 3700 to 4400 Mc. Power levels up to 2 watts make this tube ideal for reliable broadband point-to-point communication. Tuning by dielectric slug rather than variable RF gap avoids sensitivity to shock and vibration. Integral-finned cooler and higher operating temperature ratings minimize cooling requirements.

Eimac know-how in the field of ceramic-metal tube design now brings compactness, ruggedness, high performance and reliability to these important microwave frequencies.

EITEL-McCULLOUGH, INC.
SAN BRUNO CALIFORNIA
The World's Largest Manufacturer of Transmitting Tubes
Canadian Representative:
R. D. B. SHEPPARD
2036 Prince Charles Road, Ottawa 3, Canada

Eimac®

***Eimac First* with ceramic tubes that can take it**

GENERAL CHARACTERISTICS

Type	Freq. Range Mc.	Beam Voltage	Power Output Range	Reflector Voltage
1K125CA	3700-4400	1000 Vdc	1.5 to 2.0 W	0 to —1000 Vdc
1K20XS	8500-9300	300 Vdc	25 to 50 mW	0 to —250 Vdc
1K20XK	9200-10,000	300 Vdc	25 to 50 mW	0 to —250 Vdc
1K20XD	10,000-10,800	300 Vdc	25 to 50 mW	0 to —250 Vdc
1K20KA	10,700-11,700	300 Vdc	25 to 50 mW	0 to —250 Vdc

Additional Frequency Coverage to be announced soon

ft)
tron (right)